FAA-E-2699a
AMENDMENT-1
March 7, 1980

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

RCAG REMOTE MONITORING SUBSYSTEM

This Amendment forms a part of Specification FAA-E-2699, dated July 12, 1979. This Amendment consists of revisions to existing pages and additional pages to the basic specification. These revised pages and new pages are to be inserted as change pages to the basic specification. Each revision is identified by an asterisk in the left margin of the first line of the revision and an asterisk in the right margin in the last line of the revision. In addition, each page contains the date of this Amendment. The page number of those pages that form a part of this Amendment are as follows:

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FAA-E-2699a
July 12, 1979
SUPERSEDING
FAA-E-2699
March 26, 1979

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

RCAG REMOTE MONITORING SUBSYSTEM

1. SCOPE AND CLASSIFICATION

1.1 Scope. - This specification defines the Remote Monitoring Subsystem (RMS) to be used at Remote Center Air Ground (RCAG) facilities. The RCAG RMS is one of several subsystems of the Remote Maintenance Monitoring System (RMMS) that will be established at each Air Route Traffic Control Center (ARTCC). This RCAG RMS will provide the capability to remotely monitor the operational status and key performance parameters of air-ground equipment, selected environmental building parameters, engine-generator power status and site security at these facilities. Monitored parameters and status data will be transmitted periodically over existing voice-grade private line communications channels to a centrally located data processor, the Maintenance Processor Subsystem (MPS), at the associated ARTCC.

1.1.1 Operational overview. - RCAG facilities are generally remotely located, sometimes several hundred miles from the ARTCC to which they are interconnected by leased communications channels or via FAA-owned microwave link circuits. Each RCAG has one or more radio channels operating in the air-ground (A/G) VHF or UHF bands. The VHF (118 to 136 MHz) A/G communications channels are for civil aviation use and the UHF (225 to 400 MHz) channels are for military use. Control of each channel of A/G radio equipment at an RCAG is accomplished using Voice Frequency Control and Signaling (VFSC) equipment to permit each air traffic controller at the ARTCC to key one or more transmitters simultaneously and to activate/select VHF or UHF off-line transmitters or receivers as the occasion may require.

The RCAG RMS equipment will be installed in an operational air traffic control environment at both the RCAG and ARTCC facilities. Sensors will be located in each channel of A/G equipment, at the interface of each end of interconnecting voice communications channels, the engine-generator, and the environmental and security system located at the site. All sensors will be scanned automatically by the RMS and status reports transmitted to the ARTCC on command from the MPS. Monitored parameters determined to either exceed programmable alarm limits or detected to be in an abnormal state will be automatically transmitted (subject to alarm filtering) to the MPS on a priority basis as an alarm report to alert maintenance personnel at the ARTCC. In response to scheduled polls from the MPS or to manual requests that are initiated by the maintenance technician, certification report data will be assembled by the RMS and transmitted to the MPS for display on a terminal located in the maintenance area or on a portable terminal located remote to the ARTCC.

1.2 Classification. - The two types of RCAG RMS equipment covered by this specification are:

Type I equipment at RCAG facility, and
Type II equipment at ARTCC facility.

1.3 Definitions

1.3.1 Air traffic control (ATC) communications functions. - As used in this specification, the ATC communications functions refer to the voice communications, control and signaling equipment that are installed at each site and being used to provide air traffic controllers at an ARTCC with air-ground (A/G) communications and associated functions via an RCAG facility.

1.3.2 A/G radio channel equipment. - As used in this specification, A/G radio channel equipment refers to the following single frequency solid-state VHF (118 to 136 MHz) and UHF (225 to 400 MHz) radio channel equipment:

T-1108/GRT-21	VHF exciter, 10 watts
AM-6154/GRT-21	VHF power amplifier, 50 watts
T-1109/GRT-22	UHF exciter, 10 watts
AM-6155/GRT-22	UHF power amplifier, 50 watts
AN/GRR-23	VHF receiver
AN/GRR-24	UHF receiver

The VHF and UHF 50 watt power amplifiers are referred to herein as linear power amplifiers (LPA).

1.3.3 Voice frequency control and signaling (VFCS) system. - As used in this specification, the VFCS system is defined in the following specifications:

FAA-E-2018	Voice Frequency Control System
FAA-E-2431	Voice Frequency Signaling System (RCAG)

1.3.4 Voice-grade private line communications channels. - As used in this specification, voice-grade 4-wire private line communications channels are defined in the following documents:

FAA-S-1142	Voice Frequency Multi-Tone Remote Control Circuits
Publication 43201	Private Line Interconnection, Voice Applications (AT&T)

1.3.5 Type I equipment. - Defines all of the RMS equipment and documentation to be provided by the contractor and installed at an RCAG facility to meet the requirements of this specification.

1.3.6 Type II equipment. - Defines all of the RMS equipment and documentation to be provided by the contractor and installed at an ARTCC to meet the requirements of this specification.

1.3.7 On-line. - The term on-line defines the A/G radio channel equipment that has been manually selected to be operational and provide the required ATC communications functions. Over any period of time, any combination of VHF or UHF exciters (and LPAs if used) or receivers of a channel that have the same frequency may be changed from an on-line status to off-line status.

1.3.8 Off-line. - The term off-line defines the A/G radio channel equipment (exciter, LPA if used, or receiver) that has been manually changed to be nonoperational.

1.3.9 RCAG facility certification data. - As used in this specification this term refers to the measurement and recording of selected RCAG system performance parameters. Certification activities include measurements of radiated signal characteristics, monitor alarm limits, test of control functions, and status and condition of A/G equipment and engine generator equipment.

1.3.10 Alarm condition. - An alarm is a condition that is said to exist when the programmed number of pre-alarms has occurred for one or more monitored parameters.

1.3.11 Pre-alarm. - A pre-alarm is said to occur when one or more of the monitored parameters are detected to be outside of previously established values.

1.3.12 A/G radio channel. - An air ground channel at an RCAG consists of one (1) VHF and one (1) UHF frequency, with each frequency having an on-line and off-line exciter and receiver. Dependent upon a site configuration, each exciter may be installed to drive a linear power amplifier (LPA). When LPAs are used, they will be installed with both the on-line and off-line exciter on the same frequency; a mix of RF power output for any frequency will not be used. Any channel at an RCAG site may be connected for either paired, split, or selective A/G channel operation and controlled by VFCS equipment that are dedicated to this channel.

1.3.13 One-half A/G radio channel. - A "half A/G radio channel" is either one (1) VHF or UHF frequency with on-line and off-line exciters and receivers which are controlled by one (1) system of VFCS equipment that is dedicated to this channel. As such, a half channel is neither paired, split nor selective as defined below.

1.3.14 Paired A/G radio channel. - Paired channel operation is provided by using one (1) VFCS system interconnected by a 4-wire, voice-grade private line channel to transmit voice on the radio channel by simultaneously keying both a VHF and UHF on-line exciter via the VFCS push-to-talk (PTT) function. On-line and off-line equipment for the VHF and UHF frequencies of the channel are selectable independently. On-line VHF and UHF receiver outputs are combined prior to interface with the 4-wire communications channel.

1.3.15 Selective A/G radio channel. - This operation is the same as a paired A/G channel except that the PTT function can be independently selected for keying the VHF, the UHF or both on-line exciters.

1.3.16 Split A/G radio channel. - This operation is provided by using separate VFCS equipment and a separate 4-wire voice-grade private line channel for each VHF and each UHF frequency that constitutes the channel. For this configuration, all on-line VHF and UHF transmit and receive audio paths, control and signaling for each frequency are independent.

1.3.17 Terminal. - A terminal as used in this specification is a fixed keyboard/CRT/printer to be installed at the ARTCC facility and to be directly interfaced with the MPS.

1.3.18 Portable terminal. - A portable terminal as used in this specification is a portable keyboard/CRT with printer interface in accordance with EIA-RS-449 and three-way access capability: (a) on-site access to the Type I equipment; (b) access to the MPS via the Type I equipment terminal interface; and (c) access to the MPS or to the RMS via the MPS using a 2-wire dial-up circuit.

1.4 MPS at ARTCC facility. - The MPS at each ARTCC which is not a part of this specification will perform various functions in support of the RMMS concept. This data processor in conjunction with a keyboard/printer, CRT display, or both at the ARTCC will control the exchange of information between the RMS and MPS, from Sector field offices, and from work station locations via dial-access telephone exchanges to ARTCC facilities.

2. APPLICABLE DOCUMENTS

2.1 FAA documents. - The following FAA specifications and standards, of the issues specified in the invitation for bids or requests for proposals, form a part of this specification and are applicable in their entirety unless otherwise specified.

2.1.1 FAA specifications. -

FAA-E-2672	Rack Cabinet, Solid-sided and Open Sided Types
FAA-G-2100/1	Electronic Equipment, General Requirement; Part 1, Basic Requirements for all Equipment
FAA-G-2100/3	Part 3, Requirements for Equipment Employing Semi-conductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipment Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipment Employing Micro-electronic Devices
FAA-G-2300	Panel and Vertical Chassis, Rack
FAA-D-2494/1	Instruction Books, Manuscript Technical; Preparation of Manuscript and System Requirements
FAA-D-2494/2	Instruction Books, Manuscript Technical; Preparation of Manuscript Copy and Reproducible Artwork
FAA-E-2431	Voice Frequency Signaling System (RCAG)
FAA-E-2018	Voice Frequency Control System
FAA-S-1142	Voice Frequency Multi-tone Remote Control Circuits
FAA-E-2552	Technical Training

2.1.2 FAA standards. -

FAA-STD-013	Quality Control Program Requirements
FAA-STD-020	Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment (applicable to the extent specified herein)

2.1.3 Other FAA documents. -

NAS-MD-790	Interface Control Document for the Remote Maintenance Monitoring System (ICD-1), Maintenance Processor Subsystem (MPS), Remote Monitoring Subsystem (RMS). This document is hereinafter referred to as ICD-1 or ICD level 1.

(Copies of this specification and other applicable FAA specifications and standards may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the Invitation for Bids or Request for Proposals. Requests should fully identify the material desired, i.e., specification and drawings and dates. Requests should cite the Invitation for Bids, Request for Proposals, or the contract involved or other use to be made of the material.)

2.2 Military publications. - The following Military publications, of the issues in effect on the date of the Invitation for Bids or Requests for Proposals, form a part of this specification and are applicable in their entirety unless otherwise specified.

2.2.1 Military specification. -

MIL-E-17555	Electronic and Electrical Equipment Accessories and Repair Parts; Packaging and Packing of

2.2.2 Military standards. -

MIL-STD-470	Maintainability Program Requirements (For Systems and Equipments)
MIL-STD-471	Maintainability Demonstration
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety
MIL-STD-781	Reliability Design Qualification and Production Tests: Exponential Distribution
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production

2.2.3 Military handbook. -

MIL-HDBK-217 Reliability Stress and Failure Rate Data for Electronic Equipment

(Single copies of Military publications may be requested from U.S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, PA. 19120; for telephone requests, call 215-697-3321, 8:00 a.m. to 4:30 p.m., local Philadelphia time Monday through Friday. Not more than five items may be ordered on a single request; the Invitation for Bids or Contract Number should be cited where applicable. Only latest revisions (complete with amendments) are available. Request all items by document number.)

2.2.4 Industry publication. -

Publication 43201	Bell System Transmission Engineering Technical Reference (Preliminary), Private Line Interconnections, Voice Application by American Telephone and Telegraph, June 1970
EIA-STD-RS-449	General Purpose, 37 Position, and 9 Position Interface for Data Terminal Equipment and Data

(Copies of the Bell System documment may be obtained from Western Electric Company, Inc., Commercial Relations, P.O. Box 1579, Newark, N.J. 07102. Copies of the EIA document may be obtained from Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006.)

3. REQUIREMENTS

3.1 Equipment/firmware/documentation and services to be furnished by the contractor. - Using a turnkey contract approach, the contractor shall provide all the necessary engineering, management, services and materials to design, fabricate, test, deliver, install, integrate and check-out complete RCAG Remote Monitoring Subsystems (RCAG RMS) as required by this specification and the contract schedule. Complete operational subsystems shall be delivered to each RCAG and ARTCC site as specified in the contract schedule with the required documentation. Each subsystem shall be programmed with firmware to function with the specified site parameters and configuration as listed in the contract schedule. Each subsystem shall be completely assembled, wired and ready for operation upon connections to external interface circuits and primary AC power source. Instruction books in accordance with FAA-D-2494/1 and FAA-D-2494/2 shall be furnished with each subsystem and in the quantities specified in the contract schedule.

3.2 Government-furnished equipment (GFE) sensor interfaces. - The Government will provide the following monitor sensors at the RCAG site and their associated interface demarcation for interconnection to RCAG RMS equipment supplied by the contractor. (Characteristics of these sensors are defined in 3.5.)

3.2.1 Air-ground radio channel equipment sensor interfaces. -

(a) Each VHF and UHF exciter:

Forward power 10 watts (nominal)
Reverse power
Push-to-talk (PTT) status
Voice frequency (VF) audio input level
Percent modulation
On-line/off-line status
LPA/exciter operation

(b) VHF and UHF receivers:

AGC voltage
VF audio output level
On-line/off-line status

3.2.2 Primary power source interface. -

AC voltage
Engine generator (E/G) ON/OFF status
E/G master safety switch status

3.2.3 Environmental and security interface. -

Ambient room temperature (2 each)
Smoke detector
Building entrance doors (2 each)

3.3 Technical training services (option). - The contractor shall provide technical training in accordance with the contract schedule and FAA-E-2552.

3.4. General functional requirements. - The RCAG RMS shall be designed to provide the monitoring and control functions described herein, to permit orderly modular expansion of equipment, to be totally transparent to existing ATC communications functions, to facilitate maintenance, and to minimize the on-site installation effort of Type I and Type II equipment. Major functions of the RMS shall provide both automatic and manually initiated monitoring of key parameters related to A/G

communications, command and control, status, alarm and report generating functions. Parameters to be monitored by the RMS are both at the RCAG and ARTCC facilities. The RMS shall interface directly with the VFSC equipment that is installed at each of these facilities. Unless otherwise specified, Government-furnished equipment (GFE) sensors that are installed at the RCAG sites, with their associated interface demarcation terminals, shall be used for interconnection by the contractor to RMS equipment. Local and remote access functions as described herein shall provide the specified reports and control functions for maintenance activities. A functional block diagram of a typical 2-channel RCAG RMS is shown in Figure 1, with each channel of the subsystem configured for paired or selective A/G radio channel operation. Unless otherwise specified herein, all functional and performance requirements shall be met over the range of service conditions (3.12.11).

3.4.1 Type I and Type II equipment. - At the RCAG site, the controller in the Type I equipment shall scan all sensors periodically, condition the acquired data, perform analog-to-digital conversion (A/D) where required, and process each monitored parameter. On reciept of a status request message from the MPS via one of the 4-wire voice-grade private line communications channels and associated data modems, a status report assembled by the Type I processor/controller shall be transmitted to the MPS over the same 4-wire channel. Equipment design shall permit simultaneous transmission of voice, MPS to RMS command/control/report messages, and VFCS equipment control and signaling commands over each 4-wire channel without interference to each other. This simlultaneous transmission of voice, control and data over the same voice-grade communications channel is referred to hereafter as the "speech plus data" technique. RMS data shall be transmitted in the frequency band above 2400 Hz and below 3000 Hz. Each private line communications channel interconnecting the ARTCC with the RCAG shall be continuously monitored by using the receive level of the RMS pilot tone or data signal. GFE sensors are not provided for monitoring pilot tones. Figure 1 shows the pilot tone as functionally being generated by the Type I and Type II equipment modems. The tones may be generated by a separate source, at the contractor's option. Control of the data switch function shall be in accordance with protocol procedures specified in ICD #1 and #2A. (See 3.5.8 and 3.10.14). The data switch function shall not be implemented for RCAG sites provided with only one 4-wire channel.

3.4.2 Interface with VFCS system. - Type I and Type II equipment shall be designed to interface with external VFCS systems and operate simultaneously in the speech * plus data mode without mutual interference. Functional characteristics, performance * requirements and parameters of the frequency-shift tones that are used at nominally 2805 Hz+ 42.5 Hz, the on-line and off-line selection using the five (5) AM tone signaling in the voice-frequency pass band, and voice frequency response in the 300 to 2400 Hz pass band are defined in FAA-E-2018 and FAA-E-2431. In addition to the low-pass and band-pass filters in VFCS equipment with characteristics as stated in FAA-E-2431, the Government envisages low-pass, band-pass and/or high-pass filters as being required in the RMS to meet functional and performance requirements. These additional filters are as shown in Figure 1. Any major modification(s) to the VFCS equipment to implement the speech plus data mode as defined herein shall be prohibited. Modifications to VFCS equipment will be considered, but a detailed description shall be submitted to the Contracting Officer for review and approval.

3.4.3 Interface documents. - The requirements set forth in the following documents shall be used in the design of the RMS equipment to interface with external subsystems and voice grade private line communications channels.

3.4.3.1 Interface Control Document, Level 1. - External interfaces of Type I and Type II equipment shall be designed to meet all requirements that are specified in ICD Level 1.

3.4.3.2 Interface Control Document, Level 2A. - The contractor shall submit for Government approval in accordance with the contract schedule an Interface Control Document for the interface between the RMS and the MPS, and between the RMS and a portable terminal. With the exception of Section 6 in ICD Level 1, all other sections and appendicies therein are applicable in their entirety. The document shall be prepared in sufficient detail to completely describe the message formats, structures, interface characteristics, and sequences for interaction with the external terminals and the MPS.

3.4.3.3 Specification FAA-S-1142. - Currently, all control and signaling from an ARTCC to an RCAG is accomplished using VFCS equipment that is interfaced to private line communications channels, with parameters as defined in Specification FAA-S-1142. Communications channel parameters (two-way transmission) for the return circuit of the 4-wire channel from the RCAG to ARTCC may not be in accordance with all specified characteristics in FAA-S-1142, dependent upon serving company practices or unique site requirements. If not per FAA-S-1142, then return channel shall have characteristics in accordance with Tariff FCC-260, for Type 2002 private line communications channels without conditioning. Additional transmission parameters and characteristics, testing considerations and procedures for Type 2002 channels are set forth in AT&T Technical Publication No. 43201, Private Line Interconnections, Voice Applications. Data transmissions between Type I and Type II equipment shall be designed to interface with communications channels having characteristics as defined in both FAA-S-1142 and Technical Publication No. 43201 and meet requirements stated herein.

3.4.3.4 AT&T Technical Publication No. 43201. - In addition to the hybrid configuration of using FAA-S-1142 circuits to the RCAG and Type 2002 unconditioned circuits to the ARTCC from the RCAG as described in 3.4.3.3, the Type I and Type II equipment shall meet requirements stated herein when both circuits of a 4-wire channel are interfaced to a Type 2002 unconditioned channel, as further defined in AT&T Technical Publication No. 43201. Use of Type 2002 channels between the MPS and RCAG may be implemented by the Government in the future if present day VFCS equipment is replaced with a new design that may not require type FAA-S-1142 circuits.

3.4.4 Subsystem sizing/modularity. - The RMS shall be modularly expandable in design from the minimum basic size to maximum expansion as defined hereunder, and in Table I and Table II, and meet all functional and performance requirements of this specification. All firmware (3.8.1) provided with Type I and Type II equipment shall also be modularly expandable to accomodate the increase in subsystem monitoring

capability. Modular expansion of a subsystem to monitor additional external sensors, A/G radio channels and sites shall be accomplished without throwaway or modification of existing modules and with a minimal disruption of existing monitored channels while additional equipment is being installed. Each Type I and Type II equipment shall be initially programmed for the required number of channels, sites and the configuration of channel operation as specified in the contract schedule. Any changes to the site configuration requirements or site adaptation source data (3.8.1.1) will be provided to the contractor at least 60 days prior to scheduled delivery of equipment.

3.4.4.1 Type I basic size/expansion. - Basic Type I equipment shall be a one (1) channel configuration that is initially programmed for split, paired, or selective channel operation. Basic Type I configuration shall incorporate all equipment and firmware required for processing, storage, signal generation and conditioning, sensors, external interfaces, data switching and transfer, filtering, and power for a one channel configuration. This equipment includes one transmit and one receive modem, and a data switch if required by site configuration (3.4.1). If Type I equipment subsystem sizing is increased from the basic one channel configuration, it shall be readily possible to add A/G radio channels in one channel increments up to a maximum of six (6) channels in any combination of split, paired and selective channel operation. Type I equipment channel expansion shall include required cabling, pilot tone circuits, filters, signal generation and conditioning circuits, sensors, interfaces, controller memory, and firmware adaptation to meet requirements of this specification.

3.4.4.2 Type II basic size/expansion. - Basic Type II equipment shall be sized for twelve (12) each split channels to interface with up to twelve (12) RCAG sites. The basic Type II configuration shall include all equipment and firmware necessary for processing, storage, signal generation and conditioning, sensors, external interfaces, data switching and transfer, filtering, and power for twelve split channels, and twelve RCAG sites. This equipment includes twelve transmit and twelve receive modems and the number of data switches required by RCAG site configurations (3.4.1). Basic Type II equipment shall also be flexible to accommodate less than the required number of channels or sites. For example: Interface with six RCAG sites and use a total of nine channels in any configuration of split, paired, and/or selective operation. The channel flexibility shall be accomplished by wire strap option for channel assignment, and the site flexibility shall be accomplished by firmware adaptation for site assignment. If Type II equipment subsystem sizing is increased from the basic twelve channel, twelve site configuration, it shall be readily possible: to increase the number of A/G radio channels in twelve (12) channel increments up to a maximum of one hundred twenty (120) split channels; and to increase the number of RCAG site interfaces in one (1) site increments to a maximum of forty (40) sites. Type II equipment channel expansion shall include all required cabling, cabinets, pilot tone circuits, filters, sensors, interfaces, and controller memory expansion to meet the requirements of this specification. Type II equipment site expansion shall include modems, data switch (if required by site configuration), and firmware adaptation. Type II equipment which includes the basic equipment configuration and expandable in any number of channel and RCAG site interface packages up to the maximum configuration shall also permit

operation with any combination of split, paired and/or selective channel operation to be compatible with the associated RCAG sites and their Type I equipment.

3.4.5 Command/control external interfaces. - External interfaces for transmission of command and control messages that are directed to Type I or Type II equipment from either the MPS or portable terminal shall be provided in acordance with design requirements listed in Table II. Several of the interfaces vary in the number required and are dependent on the frequencies/channel configuration required for Type I and Type II operation. Equipment shall be designed to be expandable to meet maximum design requirements. The expansion increments between minimum and maximum design requirements shall be determined by the contractor and be compatible with the number of channels at each site as defined in the contract schedule. Equipment provided to each location shall be site-adapted to interface with the configuration and number of channels specified in the contract schedule.

3.4.6 Message transmissions. - All messages between the MPS and RMS shall be transmitted simultaneously as shown in Figure 1 over two (2) separate private line channels that interconnect Type I and Type II equipment with the MPS. The capability shall be incorporated in Type I and II equipment to automatically switch the input to the receive modem from one channel to the other. The controllers in Type I and Type II equipment shall independently control the selection of the channel in use for receiving messages at the RCAG and ARTCC sites. When data transmissions are disrupted or cannot be accomplished in accordance with procedures defined in ICD 1 and ICD 2A, recovery procedures shall be implemented by each controller. Data switches at the RCAG and ARTCC shall switch the modem input to the alternate channel in an attempt to re-establish data communications. All data transmissions shall be asynchronous and at a data rate of less then 1200 baud.

3.5 Monitored and reported parameters. - The sensor point interfaces listed in Table I shall be used by Type I and Type II equipment to automatically monitor and report to the MPS the status of A/G equipment, communications channels, power source, environmental conditions and building security. Table III lists each of the parameters that shall be sampled in either an asynchronous or synchronous scanning mode (3.6.1, 3.10.9.2, 3.10.9.3) and/or derived and compared against alarm threshold limits that are established for each parameter. Since the number of parameters are variable due to the site configuration, each site shall be programmed in accordance with site adaptation requirements of 3.8.1.1 and the contract schedule.

3.5.1 Isolation and loading of external sensor interfaces. - The RMS equipment interfacing to external sensor points (Table I) shall be isolated a minimum of 40dB. Also, all RMS external interfaces shall present a minimum of a 10K resistive ohm load to external sensor points.

3.5.2 A/G transmitter channels. - The capability shall be provided for monitoring the following parameters in each solid-state VHF and UHF 10 watt exciter, type T-1108/GRT-21 and T-1109/GRT-22, respectively. This requirement shall also apply to VHF and UHF 50 watt LPAs, type AM-6154/GRT-21 and AM-6155/GRT-22, respectively. The exciter and LPA configuration in Figure 2 shows on-line and off-line equipment

in a paired or selective channel configuration. Except for the installation of external forward and reverse power sensor points that are required with LPA operation, there shall be no modifications performed by the contractor to the A/G transmitter equipment. The contractor shall interface and connect with all GFE sensor points, as listed below, at receptacle J5 on the rear of each exciter chassis. Monitoring of points and alarm correlation shall be in accordance with requirements in 3.9 and 3.10. Off-line exciters and LPA shall not be monitored.

Sensor Point	J5, Pin. No.
Signal ground	A
PTT status	M
Forward power	E
Exciter/LPA operation	G
Reverse power	K
Percentage modulation	L
VF input level	P

3.5.2.1 Exciter forward power.- Forward power at the output of each on-line exciter shall be monitored, sampled rapidly and repetitively, stored and reported in accordance with Table III and 3.10.7 whenever the voltage at J5 pin G with respect to signal ground is +3.0 ± 1.0 VDC (exciter only operation). Characteristics of the sensor interface are defined in Appendix 1. A set reference control is provided in each exciter to adjust the monitor output level to 1.000 VDC for 10.0 watts forward power output.

3.5.2.2 LPA forward power.- Whenever an LPA is installed with its companion exciter, forward power of each on-line LPA of a channel shall be monitored, sampled rapidly and repetitively, stored and reported in accordance with Table III and 3.10.7 whenever the voltage at J5 pin G with respect to signal ground is 0 ± 1.0 VDC (LPA operation). A common sensor assembly shall be provided to measure forward power as shown in Figure 2. Forward power sensor measurements shall be accurate within 5 percent over the range of 30 to 65 watts. Insertion loss of the sensor assembly shall not exceed 0.5dB and protection for this device shall be provided at 100 watts minimum.

3.5.2.3 Exciter reverse power.- Reverse power of each channel at the output of each on-line exciter shall be monitored, sampled rapidly and repetitively, in accordance with Table III and 3.10.7, whenever the voltage at J5, pin G with respect to signal ground is +3.0 ± 1.0 VDC (exciter only operation). Reverse power shall not be reported to the MPS. Voltage standing wave ratio (VSWR) shall be determined and reported using forward and reverse power measurements. Characteristics of the sensor interface * are defined in Appendix 2A and 2B. A set reference control is provided in the exciter to adjust the sensor output to 0.295 VDC for VHF and 0.305 VDC for UHF with a reflected power of 1.12 watts. With a forward power of 10.0 watts and 1.12 watts reflected power, the derived value of VSWR at the exciter output equates to 2.00:1. *

3.5.2.4 LPA reverse power.- Whenever an LPA is installed with its companion exciter, reverse power of each on-line LPA of a channel shall be monitored, sampled rapidly and repetitively in accordance it Table III and 3.10.7, whenever the voltage at J5 pin G with respect to signal ground is 0 ±1.0 VDC (LPA operation). Reverse power shall not be reported to the MPS. Voltage standing wave ratio (VSWR) shall be derived and reported using forward and reverse power measurements. A common sensor assembly shall be provided and installed to measure reverse power of each LPA as shown in Figure 2. Reverse power sensor measurements shall be accurate within * 10 percent over the range of 3 to 15 watts which equates to a VSWR of approximately *

Insertion loss of the sensor assembly shall not exceed 0.5 dB and protection for this device shall be provided to 50 watts for short durations.

3.5.2.5 Push-to-talk (PTT) status. - PTT status of each on-line exciter of a channel shall be continuously monitored. The status of the sensor interface are as follows when referenced to signal ground:

Exciter keyed "ON"	less than 0.5 ohm
Exciter keyed "OFF"	greater than 10,000 ohms

Each time an exiter is keyed ON, the event shall be sensed, stored and reported in accordance with Table III.

3.5.2.6 Voice frequency (VF) input level. - Voice frequency (VF) input level to each on-line exciter of a channel shall be monitored, sampled rapidly and repetitively, and stored whenever the exciter is keyed ON. If the VF input level is above the prescribed set level, the percent modulation shall be monitored (3.5.2.7). (See Table III and Figure 5.) Reporting of the VF input level shal be accomplished by keyboard entry from a local portable terminal, a remotely located portable terminal, or the terminal at the MPS. A keyboard activated command shall enable the reporting of the VF input level value or high/low/normal and for percent modulation reporting values or high/low/normal. Characteristics of the sensor interface are defined in Appendix 3. A set reference control is provided in the exciter to adjust the sensor output to 1.5 VDC when a 1kHz test signal of 100 mv (-17.8 dBm) is applied to the *exciter audio input circuitry. Sensor output impedance is 300 ohms, resistive ± 5 percent. *

3.5.2.7 Percent modulation level. - The percent modulation of each on-line exciter shall be monitored, sampled rapidly and repetitively, and stored whenever the exciter is keyed ON as detected at the PTT sensor interface and the VF input is above a prescribed level. Characteristics of the sensor interface are defined in Appendix 4. See 3.5.2.6 and Figure 5 for percent modulation reporting requirements.

3.5.2.8 Transmitter on-line/off-line status. - The ON-line status of each exciter of a channel, and its associated LPA when used, shall be monitored by sensing the presence or absence of voltage at the coaxial relay which is used (Figure 2) to transfer the transmitting antenna between transmitters of the same frequency. The sensor interface shall be designed to connect across either a 120 VAC or a 48 VDC coil of each coaxial relay. The interface to the relay coil shall be fuse-protected. Provision shall be included to permit future interface with a coaxial relay that operates over the range of 22 to 30 VDC. Site adaptation shal be provided to permit sensing of the on-line condition of a transmitter with or without voltage being present at the relay coil. For example, depending on site engineering, voltage may or may not be present at the relay coil when #1 transmitter is on-line. The site adaptation may be accomplished either by firmware or wire-strap.

3.5.3 A/G receiver channel. - The capability shall be provided for monitoring the following parameters in each solid state VHF and UHF receiver, type AN/GRR-23 and AN/GRR-24, respectively. The receiver configuration in Figure 3 shows on-line and off-line equipment in a split configuration. The contractor shall interface and connect with all GFE monitor points as listed below at receptable J2 on the rear of

each receiver chassis. Monitoring of sensor points and alarm correlation shall be in accordance with requirements in 3.9, 3.10.5, and 3.10.6.

Monitor Point	J2, Pin. No.
Signal ground	B or H
VF output level	C, D
AGC voltage level	F

3.5.3.1 AGC voltage. - AGC voltage of each on-line receiver of a channel shall be monitored and stored concurrently with the percent modulation measurement(s) of the exciter and LPA, if in use, of the same frequency. Variations in the sensor interface are a function of received signal level and shall vary between 0 and +18 VDC, referenced to signal ground.

3.5.3.2 VF output level. - The voice frequency output level of each on-line receiver of a channel shall be monitored, sampled rapidly and repetitively, and stored concurrently with the percent modulation measurement(s) of the exciter and LPA, if in use, of the same frequency. The output level of each off-line receiver shall be sampled periodically for S+N/N performance in accordance with 3.10.8. Interface characteristics of each receiver output circuit at the sensor interface are as follows:

Impedance	600 ohms resistive, balanced
Output level	-40dBm to 0dBm

3.5.3.3 Receiver on-line/off-line status. - The status of each receiver of a channel shall be monitored by sensing the presence or absence of power at the coaxial relay which is used (Figure 2) to transfer the receiving antenna between receivers of the same frequency. The sensor interface shall be designed to connect across either a 120 VAC or a 48 VDC coil of each coaxial relay. The interface to the relay coil shall be fuse protected. Provision shall be included to permit future interface with a coaxial relay that operates over the range of 22 to 30 VDC. Site adaptation shall be provided to permit sensing of the on-line condition of a receiver with or without voltage being present at the relay coil. For example, depending on site engineering, voltage may or may not be present at the relay coil when #1 receiver is online. The site adaptation may be accomplished either by firmware or wire-strap.

3.5.4 Pilot tone signals. - Pilot tones shall be generated by Type I and Type II equipment and shall be interfaced to each private line communications channel at the RCAG site and its associated ARTCC site. The channel receive level of each pilot tone at each site shall be monitored and stored. A pilot tone alarm report shall be sent to the MPS when the receive pilot tone level is not within alarm limits for the specified number of samples (pre-alarm filtering, 3.10.5). VF input signals (3.5.2.6) shall not be used for monitoring pilot tones.

3.5.5 Power source. - AC and DC voltages that power RMS equipment shall be monitored in Type I equipment as specified in the following subparagraphs.

3.5.5.1 AC voltage. - A GFE interface point per Table I will be provided on the load side of the E/G transfer switch to monitor the line-to-neutral AC voltage on single-phase primary power or single-phase emergency power from the engine-generator

(E/G) at the RCAG site. Provision shall be included to monitor the 120 VAC voltage (nominal) between line and neutral of a single-phase 2-wire circuit, between each line and neutral of a single-phase 3-wire circuit, or two of the three voltages between line and neutral of a 3-phase, 4-wire circuit. When only one voltage is monitored, masking (3.8.1) shall be accomplished for the remaining AC voltage sensor point.

3.5.5.2 DC voltage. - The DC voltage power source for Type I equipment shall be monitored.

3.5.5.3 E/G master safety switch status. - A GFE monitor point consisting of a normally-closed Form B contact shall be monitored to determine the presence of an E/G malfunction. In the normal state, there shall be less than 0.5 volt DC residual voltage at this sensor point. In the E/G alarm state, either +24 VDC $\pm$ 10 percent or +32 VDC $\pm$ 10 percent shall appear on the sensor interface.

3.5.5.4 E/G OFF/RUN status. - A GFE monitor point shall be monitored to determine when the E/G is in either the "OFF" or "RUN" status. The monitor point will consist of a normally-open Form A contact representing the E/G in the "OFF" status with a loop resistance of greater than 10,000 ohms. With the E/G in "RUN" status, loop resistance of the monitor point will be less than 1.0 ohm.

3.5.6 Environmental and security status. - GFE sensor points listed in the following subparagraphs shall be monitored by Type I equipment.

3.5.6.1 Ambient room temperature. - Two (2) temperature sensor points shall be monitored and reported in 1°C steps over the range of -20°C to +70°C. One sensor will be located in the E/G room, the other being located in the electronics equipment room. Characteristics of the sensor points are defined in Appendix 5. When the temperature of either sensor exceeds 66°C for more than one (1) minute, a "fire" alarm report shall be transmitted to the MPS.

3.5.6.2 Smoke detector. - A smoke detector located in the electronics equipment room shall be monitored and an alarm report transmitted to the MPS when the detector's normally-closed Form B circuit changes state. The normally-closed loop resistance will be less than 1 ohm; in the alarm state, loop resistance will be greater than 10,000 ohms. An alarm report shall be transmitted whenever the contacts are in the open state.

3.5.6.3 Building entrance doors. - Status of normally-closed Form B monitor point contacts on each of two (2) building entrance door switches shall be monitored and reported as a "security" alarm to the MPS when either or both sensor contacts open. Loop resistance of the closed state will not exceed 1.5 ohms; the alarm or open state will exceed 10,000 ohms. Whenever a contact(s) change to the open state, a timer shall be activated and an alarm report transmitted in the time specified in 3.10.5 unless inhibited by the security sign on-intrusion alarm (3.5.6.4).

3.5.6.4 Security sign on-intrusion alarm. - When maintenance personnel enter the RCAG building they will be required to "sign-on" using their portable terminal within two minutes after entering the building. The RMS equipment shall, at the time of entry, start a two minute timer and shall send an intrusion alarm report after two minutes has elapsed if a "sign-on" has not occurred.

3.5.7 Subsystem errors. - Errors detected due to faulty equipment operation or data communication errors that are detected using the cyclic redundancy check (CRC) technique in accordance with ICD 1 shall be reported as "monitor" or "CRC" alarms in accordance with 3.6.2.1 and 3.10.16.

3.5.8 Data switch position. - Position of data switches in Type I and Type II equipment shall be controlled by their associated controller. Each change of position of a switch shall be accomplished in accordance with 3.10.14 and reported to the MPS.

3.6 Controller modes of operation. - The controller in Type I and Type II equipment shall be designed to function in six (6) operational modes: scanning; report processing; command and control processing; data communications; start-up/recovery; and self-test mode.

3.6.1 Scanning mode. - All monitored parameters (3.5) shall be examined individually in a sequence to be defined by the contractor unless otherwise defined hereunder. When all monitor sensor points have been examined in a prescribed sequence, one scan cycle shall be completed. The scan shall consist of two subscan cycles, an asynchronous sampling and a synchronous sampling cycle. See paragraphs 3.10.9.2 and 3.10.9.3. Unless a scan cycle is interrupted by another mode of higher controller operational priority, one synchronous subscan cycle shall be completed in less than 10 seconds.

3.6.1.1 Asynchronous sampling, - Monitored parameters for exciters, LPAs when used, and receivers are random variables in terms of ATC operations and traffic. Accordingly, the following sensors in the on-line exciters, LPAs and receivers shall be sampled when an exciter is keyed via PTT:

(a) PTT status

(b) Forward power (including LPA, if used)

(c) Reverse power (including LPA, if used)

(d) Percent modulation

(e) VF input level

(f) AGC output level

(g) VF output level

3.6.1.2 Synchronous sampling. - All sensors not included in 3.6.1.1 and defined in 3.5 shall be sampled during a synchronous subscan cycle. This includes pilot tone levels, off-line receivers, power source, environmental security sensors, self-test (3.6.6), and restart timer reset (3.10.15.1)

3.6.2 Report processing mode. - Report generating and processing shall be provided and structured in accordance with message formats and interactive procedures specified in ICD 2A for machine-to-machine transmission from the RMS to MPS. For the man-machine mode, the message report format defined in ICD 2A shall be used for interaction using the on-site portable terminal for command/control and report requests that can be addressed to either the MPS or directly to the Type I equipment.

3.6.2.1 Alarm report. - Alarm processing and reporting shall preempt and interrupt all other report processing modes. Paragraph 3.7 defines priorities for the controller operational modes. An alarm report shall be generated and transmitted automatically to the MPS as soon as the pre-alarm filtering and alarm correlation criteria (3.10.5, 3.10.6) are satisfied. Monitor, CRC and start-up/recovery alarm reports shall also be reported as specified in 3.10.15.1 and 3.10.16. Alarm reports shall be processed and transmitted to the MPS as they are detected, on a first-in first-out basis. Alarm reports shall be retained in storage until they are transmitted to and acknowledged by the MPS. This requirement applies to pre-alarm data and alarm reports. An alarm report shall not include the value of the measured parameter.

3.6.2.2 Status report. - Status report requirements shall include various types of requests which can be manually initiated by maintenance personnel for either a specific status or sampling of one or a group of monitored parameter values or a complete certification data report (3.6.2.3.). Examples of these requirements include: all monitored parameters of a specified A/G radio channel; one or more pilot tone level measurements at a site; primary power data; environmental or security data/status. Another example of a status report requirement is the capability to select a specific parameter of on-line or off-line equipment and very rapidly sample the monitored value while adjustments are being performed to the externally monitored equipment. The capability shall be provided to interact and respond to status report requests from the MPS or directly from the portable terminal.

3.6.2.3 Certification data report. - A certification data report shall be generated and transmitted in response to a request received from either the MPS as part of a normal scan cycle of the MPS polling sequence, a status report request (3.6.2.2) from the on-site portable terminal, or a remote portable terminal which has acoustically coupled dial-access to the MPS. A certification data report shall contain the status of all monitored parameters for Type I and Type II equipment as specified in Table III. Figure 4 shows a sample printout format of a certification data report. The report shall also include the following summary data:

(a) Alarm threshold limits for each parameter (3.8.3)
(b) Pre-alarm occurrence by parameter (3.10.5)
(c) PTT occurrences by frequency of each A/G channel (3.5.2.5)
(d) Security access data (3.6.3.1)
(e) By parameter, the number of alarm disables that are active (3.6.3.4)

3.6.2.4 Message report. - Type I and Type II controller equipment shall provide the capability for free-form English text in the conversational mode (3.6.4.7) by man-machine interaction between the on-site portable terminal and terminal at the MPS, or between a portable terminal remote to the ARTCC and either the terminal at the MPS or the on-site portable terminal at the RCAG.

3.6.3 Manual command and control mode. - Each type controller shall be provided with a command and control mode to be used for responding to manually initiated requests from maintenance personnel for implementing specific command or control *functions and for requesting status, certification or message reports. Each background entered function shall be acknowledged when received. This acknowledgement shall be transmitted to the MPS and on-site portable terminal, if being used, as a status change report (3.6.2.2).The man-machine request functional capability shall be * provided via either the on-site portable terminal, a portable terminal remote to the MPS, or from a terminal local to the MPS.

3.6.3.1 Controller security. - The controller in Type I equipment shall incorporate security access codes (passwords) to disregard functional commands from a portable terminal or terminal without first interacting with a valid sign-on procedure. Provisions for up to eight each programmable passwords shall be provided and stored in RAM (3.8.2) with up to eight characters per word. When one of these passwords is entered at a portable terminal or terminal, the controller shall respond to all subsequent commands for report processing (3.6.2) and control commands at external interfaces as listed in Table II. Two of the eight passwords when entered at the portable terminal or terminal shall also enable the controller to process subsequent requests for changing programmable alarm limits (3.6.3.2), as well as the processing of report requests and control of external interfaces. The eight passwords for each RCAG site shall also be stored in the MPS and functionin the same identical manner *as described above in controlling/processing requests when addressing Type I and Type * II equipment. A prescribed sign-off procedure shall also be followed. Each sign-on and sign-off shall be transmitted to the MPS for logging in the certification report data.

3.6.3.2 Programmable alarm limits. - Unless otherwise specified, a high and low alarm threshold value for each like parameter (i.e., percent modulation) shall be stored in programmable memory. The range and granularity of the values for these thresholds are listed in Table III. In the start-up or recovery mode (3.6.5), all alarm limits will be transmitted by the MPS for assignment in storage areas designated by the controller. Whenever an alarm limit is changed from the established standard value (initial standard values 3.8.3), this change shall be incorporated in the next certification data report and highlighted by an asterisk (*) in the parameter portion of this report (Figure 4).

3.6.3.3 Master reset. - A master reset function shall be provided to clear (zero-out) each monitored parameter data sample that is stored in memory. The controller shall inhibit alarm reporting for each parameter upon receipt of this command until a new value of the monitored parameter has been sampled. The alarm function for each parameter and its associated alarm threshold shall be reactivated after the new value for the parameter has been sampled and stored. The reset function shall be manually activated via a portable terminal, a terminal, an MPS message, or as part of the start-up/recovery mode (3.6.5).

3.6.3.4 Alarm disable.- Capability shall be provided to disable any or all alarm reporting of monitored parameters. To guard against inadvertant disabling of alarms, all disabled alarms shall be included in the certification report.

3.6.3.5 PTT and on/off-line select (option).- When specified in the contract schedule, the PTT and on-line/off line command capability (Table II) shall be provided via the terminal interaction functions in 3.6.4.3 through 3.6.4.6. Form A relay contacts shall be provided and used to bridge existing relay contacts in the VFCS equipment to activate PTT and on-line/off-line selection of A/G exciters and receivers. (See Figure 2, Notes 4 and 5.) Selection of the PTT command at a portable terminal or terminal keyboard shall key the selected on-line exciter(s) for a 4-second period. Changing the status of a transmitter or receiver from on-line to off-line or vice versa shall also be accomplished by terminal keyboard entry to provide 0.5 second dry closures, utilizing eight (8) separate Form A contacts per VHF/UHF channel, each rated at 1 ampere (resistive), 50 VDC.

3.6.3.6 Engine-generator start/stop.- A control capability shall be provided by keyboard * entry at either a terminal or portable terminal to start and stop the engine generator (E/G-Table II) at the RCAG site. In the E/G START mode, solid-state optically isolated Form A contacts shall be provided and closed at the external interface circuit which will start the E/G and place it on-line to assume the site load. When the E/G STOP command is entered, the Form A contacts shall be opened at the interface circuit which will cause the E/G to stop in accordance with its prescribed monitor/control shutdown cycle. The Form A contacts shall be rated for at least a 2 ampere resistive load, 130 VAC. Contact voltage drop in the START mode at rated current shall not exceed 1.5 volts; in the STOP mode, leakage current at rated voltage of the contacts shall not exceed 6 ma.

3.6.3.7 HVAC lockout.- A control capability shall be provided by keyboard entry at either a terminal or portable terminal to disable external thermostat circuits which control heating-ventilation and air-conditioning (HVAC-Table II) equipment at the RCAG site. In the HVAC LOCKOUT mode, solid-state optically isolated Form A contacts shall be provided and closed at the external interface circuit which will disable building thermostat circuits. When the HVAC NORMAL mode is entered, the Form A contacts shall be opened which will enable the thermostat circuits. Contact load rating, voltage drop and leakage current requirements shall be the same as specified in 3.6.3.6.

3.6.4 Data communications mode.- The functional capability shall be provided for Type I and Type II controllers to communicate, interact and be responsive to commands, control and report processing requests from the MPS, the on-site portable terminal and local/remote terminals to the MPS. The data communications link control procedures specified in ICD 1, and protocol parameter values and data format requirements in ICD 2A to be developed by the contractor in accordance with 3.4.3.2, shall apply as stated in the following subparagraphs.

3.6.4.1 Type I - MPS link. - Automatic machine-to-machine communications capability shall be provided between the Type I controller and MPS ICD 1 and ICD 2A requirements shall apply. The interface between the MPS and modems in a Type I-Type II equipment link (Figure 1) shall be in accordance with the EIA-RS 449 requirements and employ a low-speed asynchronous bit serial format.

3.6.4.2 Type II - MPS link. - For the Type II-MPS machine-to-machine link, the capability shall be the same as specified in 3.6.4.1. Use of modems on this local link are not required.

3.6.4.3 On-site portable terminal-Type I link. - For this local man-machine communications capability between the portable terminal and Type I controller, a stand-alone communications functional capability shall be provided. This function will be used during a failure of private line communications channels or when a faster interaction response with equipment is required. The contractor shall develop and define the protocol and data format procedures required to be used for interaction with the terminal. The proposed protocol and procedures shall be submitted to the Government for review/approval. The approved protocol and procedures shall be incorporated in ICD 2A. A fixed-format of abbreviated English text with numerics shall be used for this interactive mode. The format shall be sufficiently comprehensive to preclude need for excessive abbreviation or use of any numerical coding to represent command, control or request of entries or readout. It is estimated that at least a 200-word fixed format reportoire shall be required to implement the required man-machine interaction. This reportoire shall be the same for all Type I and Type II equipment interactions.

3.6.4.4 On-site portable terminal - Type I - MPS link. - For this man-machine communications capability between the portable terminal-Type I controller - MPS link, ICD 1 and ICD 2A requirements shall apply. Only the transparent mode specified in ICD 1 shall be used and the same man-machine interaction of fixed message format structure/procedrues that are required for local man-machine interaction (3.6.4.3) shall be used.

3.6.4.5 Terminal - MPS - Type I. - The capability of interacting between Type I equipment and a terminal, either local or remote to the ARTCC facility or a portable terminal at the RCAG, shall be provided and use the same protocol and format procedures as in 3.6.4.4. Direct access capability to a Type I controller from a terminal other than the on-site terminal shall not be provided.

3.6.4.6 Terminal - MPS - Type II. - This capability shall be provided and use the same communications link procedures as in 3.6.4.4.

3.6.4.7 On-site portable terminal - conversational mode. - Capability shall be provided to interact between a portable terminal at an RCAG and a terminal at the ARTCC or remote to the ARTCC using the MPS-RMS data communications link. Free-form English text messages (3.6.2.4) will be used to provide a conversational mode of interaction between terminals. Protocol procedures in accordance with ICD 1 shall be used. Definitive procedures for establishment and termination of message transmissions shall be developed by the contractor and incorporated in ICD 2A.

3.6.5 Start-up or recovery mode. - Each type of equipment controller shall include provisions for both automatic and manual modes of start-up or recovery resulting from a primary power failure or detection of equipment-induced errors. Functional constraints concerning this mode of operation are specified in 3.10.15.

3.6.6 Equipment self-test mode. - Each equipment type shall incorporate self-checking functions as part of the synchronous sampling cycle (3.6.1.2) to detect and report equipment-induced hardware or firmware errors as specified in 3.10.16.

3.7 Controller operational priorities. - Design of equipment and firmware shall implement, in descending order, the operational priority sequence as listed below. This sequence shall be implemented to meet subsystem throughput/response time requirements (3.13.3) and provide the required capability for automatic interaction between the MPS and RMS, and manual interaction between the RMS/MPS and terminal equipment (3.6.4).

(a) Start-up or recovery (3.6.5)

(b) Equipment self-test (3.6.6)

(c) Command and control (3.6.3)

(d) Data Communications (3.6.4)

(e) Report processing (3.6.2)

- Alarm (3.6.2.1)
- Status (3.6.2.2)
- Certification (3.6.2.3)
- Message (3.6.2.4)

(f) Scanning (3.6.1)

3.8 Storage functions. - Both nonvolatile and volatile memory shall be incorporated as part of the equipment design in meeting the functional requirements for the Types I and II equipment controllers.

3.8.1 Read-only-memory (ROM). - ROM shall be provided as nonvolatile memory for storage of the following controller functions:

(a) Executive/operational/control

(b) Self-test diagnostics

(c) Operational priorities

(d) Sizing/modularity site adaptation parameters

Design of the software when implemented in firmware shall also include linkages in the site adaptation parameters to expand from the basic subsystem configuration up to the maximum size (3.4.4). Provisions shall be included to permit masking out of any combination and number of monitored parameters as listed in Table I and reported per Table III. This masking during "burn-in" of data to be permanently stored in the ROM shall permit deletion of a specific monitored parameter(s) when not implemented at a facility. Examples of this masking capability are deletion of monitoring the E/G parameters where this form of emergency power is not provided, or the deletion of monitoring the received pilot tone level in Type I equipment when the private line communications channels do not originate at an ARTCC facility. This deletion requirement, refers only to output functions and shall be accomplished by one of the following methods:

1. by outputting unique null values (e.g., xxx) in reports; or,

2. not reporting that nulled parameter(s).

3.8.1.1 Site adaptation data. - The government will provide the contractor a listing of site adaptation data that shall be permanently stored in each ROM for Types I and II equipment. Site adaptation data will include frequency assignments for each exciter and receiver of a channel and specify the numbers and types of sensor point interfaces to be monitored in accordance with Table I. Initial site adaptation data will be identified in the contract schedule. Not less than 60 days prior to scheduled equipment delivery to a site, the Government will provide to the contractor update data on these data, if changes are required.

3.8.2 Random-access-memory (RAM). - RAM shall be provided in volatile memory for storing the controller functions/data listed below. Other functions that the contractor may require in his design shall be submitted to the Government for review/approval at or prior to initial design review (3.17).

(a) Alarm threshold limits (3.6.3.2)

(b) Processed values, when required, of all monitored parameters (3.9)

(c) All report data (3.6.2)

(d) Controller security passwords (3.6.3.1)

(e) Other contractor-required data

3.8.3 Initial alarm threshold limits. - Alarm threshold limits to be programmed in RAM and used for factory and on-site testing (4.0) shall be as listed below. Capability shall be provided to program alarm limits over the range of low and high limits listed in Table III.

Initial Alarm Threshold Limits

Alarm Report

Parameter	Low limit	High limit
a. Exciter forward power	8.0	12.0
b. Exciter VSWR	1.1:1	2.0:1
c. LPA forward power	35	55
d. LPA VSWR	1.1:1	2.0:1
e. VF input level[1,4]	-35 dBm[3]	-21 dBm
f. Percent modulation level	60	95
g. AGC voltage	6	-
h. VF output level[4]	-11 dBm	-2 dBm
i. S+N/N	10	35
j. Pilot tone receive level[2]	—	—
k. AC voltage	105	130
l. DC voltage	22	26
m. Fire	-	66°C

NOTES:

1. VF input level used for monitoring percent modulation alarm threshold.

2. Pilot tone receive alarm limits will be established by the Government after the contractor defines nominal transmit/receive levels which comply with AT&T Publication 43201 for composite signal level.

3. VF signals at or above this level shall enable the percent modulation monitor function (see Figure 5).

4. VF levels are based on a 1 KHz test tone signal.

3.9 Processing functions. - Types I and II equipment shall incorporate the signal conditioning, analog-to-digital (A/D) conversion, algorithms, switching and computational capability to monitor all required sensor point interfaces (Table I) and process data for the required reports (3.6.2). In addition, the contractor shall comply with other alarm processing requirements and functional constraints listed in 3.10 which can impact the equipment design in establishing the required processing functions for the controllers.

3.10 Functional constraints. - Types I and II equipment shall incorporate the following functional design features in equipment and software/firmware requirements.

3.10.1 Controller design. - The controller shall be a digital circuit design, utilizing a micro-processor/micro-computer rather than an analog design. Digital circuit design shall be used throughout the equipment except where otherwise specified or where demonstrated to be impracticable.

3.10.2 Subsystem transparency. - The RMS shall be transparent to the operation and control of the external VFCS equipment. This requirement shall be met with or without power being applied to RMS equipment. During normal operation or as a result of either failure or malfunction, the RMS equipment shall not in anyway impact ATC communications functions, operation of VFCS equipment, or result in abnormal tones, signals, etc., appearing on private line communication channel interfaces.

3.10.3 Subsystem lock-up. - Design of equipment controllers shall eliminate or minimize the potential for abnormal equipment operation such as the firmware entering and remaining into an indefinite state or indefinite loop condition. During sybsystem power up or power down, operation or conditions of transient AC power fluctuations, external interface control functions (Table II) shall be inhibited; also, during these periods false alarms shall not be generated. (See 3.10.15 for other requirements regarding equipment start-up or recovery.)

3.10.4 Power failures. - The Type I equipment controller shall be designed to initiate the start-up/recovery mode (3.6.5) after restoration of power.

3.10.5 Pre-alarm filtering. - Excluding the parameters listed below, all Table III monitored parameters shall be subjected to the pre-alarm filtering. The number of pre-alarm occurrences shall be a programmable function, for each like parameter, which is adjustable from one (1) to seven (7) occurrences before an alarm report is transmitted. For example, when the pre-alarm occurrence number has been programmed for a count of three when any given monitored parameter is first detected to be outside of previously established values, this pre-alarm occurrence shall be stored. If two additional pre-alarm occurrences are detected in different but consecutive scan samples, either asynchronous or synchronous sub scans (3.6.1), an alarm report shall be transmitted to the MPS within 2.5 seconds of the detection of the third pre-alarm occurrence. If three samples are not detected, the number of pre-alarm occurrences (one or two) for the parameter shall be included in the next polling requested from the MPS for the certification report data. The following parameters shall not be subjected to pre-alarm filtering. An alarm report shall be transmitted to the MPS as soon as detected, subject to the following time delays listed below:

Parameter	Time Delay
a. Fire (+66°C)	60 seconds
b. E/G ON status	0 seconds
c. E/G master safety ON	0 seconds
d. Building entrance door	120 seconds

Equipment shall be delivered with all monitored parameters, programmed for one (1) pre-alarm occurrence.

3.10.5.1 Return-to-normal (RTN). - Excluding parameters a) through d) listed in 3.10.5, all parameters listed in Table III shall be subject to return-to-normal (RTN) filtering. When a monitored parameter value returns to within programmed alarm limits after an alarm report for the parameter has been transmitted, this RTN occurrence shall be stored. If the required number of additional RTN occurrences in different but consecutive scan samples occur, an RTN report shall be transmitted to the MPS. A summary by parameter of RTN reports shall be included in each certification data report. Time delay for fire and building entrance door alarms shall not apply when these monitored parameter return to nominal.

3.10.6 Alarm correlation. - Correlation shall be performed on the following monitored parameters as described below:

(a) A low modulation alarm report shall not be reported to the MPS if the exciter VF input level is not above the required threshold setting to enable reporting a low modulation alarm report.

(b) A modulation alarm or VSWR alarm shall not be reported if RF power is not within alarm threshold limits at the output of the exciter, and LPA if used.

(c) When data samples for exciter (and LPA if used) forward power, VF input and percent modulation are within their alarm thresholds, the on-line receiver of the same frequency shall be sampled for AGC voltage and VF output. The delay requirement for sampling and incremental adjustment capability shall be the same as in 3.10.7. If either receiver parameter is found not to be within alarm limits, an alarm report(s) shall be transmitted (subject to pre-alarm filtering).

(d) The S+N/N measurement sample for any off-line receiver shall not be initiated when any exciter is in the PTT ON state. The S+N/N sample shall be deferred until the next synchronous subscan cycle. In addition, any in-process S+N/N measurement sample(s) shall be discontinued and voided if any PTT changes from an OFF to ON status during the sample period.

(e) Stored parameter values that pertain to on-line or off-line transmitters or receivers shall be deleted from reports or designated by a special character in reports if said on-line or off-line equipment is switched to its alternate configuration and not updated e.g., #1 transmitter forward power is stored, then #2 transmitter is switched on-line and not keyed. The deletion or designation of the parameter shall be negated when the parameter is updated to reflect the present configuration.

3.10.7 RF power measurement samples. - Sampling of forward and reverse power shall be delayed over a range of 0.5 to 3.0 seconds after detecting the PTT ON state for the exciter. After this delay, power shall be sampled rapidly and repetitively, stored and compared against alarm thresholds as long as PTT is in the ON state. Adjustment of delay shall be provided in 0.25 second increments over the range by means of wirestrap option. Equipment shall be delivered with the delay set for 1.0 second.

3.10.8 S+N/N measurement sample. - A fixed level 5.0 $\pm$ 1.0 microvolt RF signal that is modulated 30 $\pm$ 5 percent by a 1 kHz tone shall be applied to the RF input of an off-line receiver. This composite signal (S) shall be applied to the receiver for approximately a 0.5 second period, and the receiver's VF output shall be sampled during this period. Immediately following, another 0.5 second sample period shall be applied with an unmodulated 5 microvolt RF signal (N), and resultant VF output sampled. These two signal values shall be used to compute, store and report the

sampled S+N/N in dB. The dB value shall be computed as follows: $dB=20 \log_{10} (S+N/N)$. An RF test signal shall never be applied to an on-line receiver. Sample measurements shall not be initiated within 50 ms after any PTT status changes from ON to OFF state. Adequate shielding and isolation of the RF test oscillator unit(s) shall be provided to prevent any measurable interference from occurring at anytime in other on-line or off-line receivers of the same or different frequency. Over the range of service conditions the output frequency of the RF test signal shall be within 10 ppm of the receiver channel center frequency. The RCAG frequency assignments are in the VHF (118 to 136 MHz) and UHF (225 to 400 MHZ) range. Over these frequencies, channel frequency assignments shall be at 25 kHz increments. A wire strap option shall be provided to permit adjusting the modulated and unmodulated test signal sample period from 0.25 second to 2.0 seconds in 0.25 second increments. Equipment shall be delivered with the total sample period set for 1.0 second.

3.10.9 Time restrictions. - Equipment design and firmware/software implementation shall meet the following time limitations.

3.10.9.1 Alarm report. - Alarm reports in accordance with 3.6.2.1 shall be transmitted to the MS within 2.5 seconds after the controller has established that a monitored parameter exceeds the alarm threshold limits and meets alarm correlation and pre-alarm filtering reqirements (3.10.5, 3.10.6). This shall be a subsystem time restriction for reporting an alarm at the RMS-MPS interface for alarms reported by Types I and II equipment. The time limit excludes propagation delay of private line channels. In the event of multiple alarms, they shall be reported on a first in-first out basis.

3.10.9.2 Asynchronous data sampling. - Design of the controller shall permit sampling of all sensor points (Table I) that are associated with the PTT status signal for on-line exciters and receivers, and the processing/reporting of any parameter values that are found to be in an alarm condition with the time limits of 3.10.9.1. This requirement shall be met for a configuration up to a maximum of 6 A/G channels, operated in either the paired, split or selective mode with all frequencies being keyed ON simultaneously.

3.10.9.3 Synchronous data sampling. - All sensor points (Table I) that are not associated with the PTT status signal shall be sampled and compared against alarm threshold *limits at least ever 10 seconds. *

3.10.9.4 Subsystem interaction time. - The start of transmission of either a certification or status report shall start within 0.5 second after receiptr of the request from the MPS.

3.10.9.5 Man-machine interaction time. - Interaction time for report processing of man-machine command/control requests shall not exceed the following time limitations:

Interface	Time Limit
(a) Local portable terminal - Type I (3.6.4.3)	0.5 second
(b) Terminal-MPS - Type II (3.6.4.6)	10.0 seconds
(c) Local portable terminal - Type I-MPS (3.6.4.4)	10.0 seconds
(d) Terminal-MPS-Type I (3.6.4.5)	10.0 seconds
(e) Remote Portable Terminal (dial-up) MPS-Type I or Type II	12.0 seconds

Time limits for (c), (d) and (e) above include 2.5 seconds which are allocated to the MPS for response time. Time limits shall exclude propagation delays over communications channels. Measurement of time starts with depressing ENTER on the keyboard until start of the first character of the response report.

3.10.10 Parameter limiting. - Sampled parameter values that may be less than or more than the range specified in Table III shall have the value reported as "ALM" in lieu of a quantitative value. Example, if the sampled exciter forward power measures less than 5 or more than 15 watts, the value shall be reported as ALM in the certification or status report data.

3.10.11 Communiations channel interface. - Equipment external interfaces shall be designed for balanced operation when connected to the private line communications channels and interfacing VFCS equipment (3.4.2, 3.4.3.3, 3.4.3.4). Interface parameters shall be as follows:

Parameter	Requirement
(a) Impedance	600 ohms + 20%, resistive over the voice band of 300 to 3000 Hz
(b) Isolation to ground	At least 10 megohms DC, at least 25,000 ohms AC
(c) Composite voice, VFCS and RMS signal power over the 300 to 3000 Hz band, averaged over any 3-second interval	-7 dBm at common carrier's "+6TLP" in accordance with AT&T Publication 43201
(d) Transmitted VF signal power in 300 to 2400 Hz band	-9.4 dBm averaged voice power (-8 vu) over any 3-second interval based on a 0 dBm 1kHz test tone line-up on a FAA-S-1142 circuit
(e) Transmitted VFCS FSK tone power	-16 dBm

	Parameter	Requirement
(f)	Transmitted and received RMS pilot tone or data signal power	To be determined by the contractor; in accordance with AT&T Publication 43201; and subject to approval by the Government
(g)	Transmitted signal power roll-off above 3995 Hz	In accordance with AT&T Publication 43201, Table D
(h)	Common carrier frequency shift of received RMS pilot tone/data signals	Up to + 5 Hz in accordance with error, i.e., frequency AT&T Publication 43201, paragraph 4.16

All other interface parameters shall be as specified in interface documents for the communications channels (3.4.3.3., 3.4.3.4).

3.10.11.1 Transmit level control. - A level control shall be provided to adjust the transmit level of each pilot tone and data signal. The level when measured at the communications channel interface shall be continuously adjustable over the range of at least 0 dBm to -20 dBm.

3.10.11.2 Receive sensitivity and level control. - The capability shall be provided to perform the required data communications function between Type I and Type II equipment and to monitor pilot tone signals with the level of the received signals over the range of -15dBm to -45dBm, when measured at the communications channel interface. A control shall be provided for each pilot tone and data receiver function to adjust equipment for operation over this range.

3.10.11.3 Filter design. - All filters required to implement the speech plus data technique (3.4.1, Figure 1) shall be passive in design. No active electronics shall be used. Insertion loss over the pass band of a filter that is part of the ATC communications function via RMS equipment shall not exceed 2 dB. The pilot tone monitor signal (3.5.4) and signals associated with the low-speed data communications link between the MPS and RMS shall not interfere with operation of VFCS functions or be present in the 300 to 2400 Hz voice frequency pass band. To meet these requirements, design of filters required for RMS equipment operation shall incorporate filter characteristics and use transmit/receive levels to also permit simultaneous operation with voice communications and VFCS equipment. Filter design for use in the speech-plus-data transmission link to remove pilot tones and data signals from the voice frequency pass band and FSK pass band of the VFCS equipment shall be based on the following:

(a) VF pass band 300 to 2400 Hz in accordance with filter and hybrid characteristics as specified in FAA-E-2341

(b) FSK frequencies 2805 Hz + 42.5 Hz in accordance with FAA-E-2431, and filter and hybrid characteristics as specified in FAA-E-2431

(c) FAA-S-1142 and AT&T Technical Publication 43201

The characteristics of the filters in conjunction with the proposed data transmission baud rate(s) and transmit/receive levels for data signals and pilot tones shall be submitted to the Government for review/approval at or prior to the initial design review.

3.10.12 RMS contractor-MPS contractor coordination. - The RCAG RMS contractor shall have prime responsibility for development of ICD 2A required in 3.4.3.2 and the fixed-format abbreviated English test required in 3.6.4.3, 3.6.4.5, 3.6.4.6 and free-form English messages (3.6.4.7). The interface and fixed format reportoire to be used by any terminal, portable or fixed, shall be identical while interacting with either the MPS equipment or the RMS equipment. The RMS contractor shall perform all necessary coordination required with the MPS contractor, through the Contracting Officer, to assure that the fixed format messages are compatible for use with the minicomputer (16 bit word or larger) that will constitute the processor capability of the MPS.

3.10.13 Monitor calibration. - Type I and Type II equipment shall incorporate provisions for test, adjustment and calibration of monitored parameters and their alarm threshold settings. This requirement shall be accomplished without interfering with the normal operation of on-line and off-line external equipment or other sensor interface points listed in Table I. All tests required to establish calibration standards for the equipment shall be accomplished via keyboard entry/printout/display at the portable terminal or at the terminal located at the ARTCC. With these standards established, RMS equipment shall then be adjusted to the calibration standards.

3.10.14 Data channel switching and status. - Switching of the receive modem input from one communications channel to the other shall be accomplished by the data switches to be provided in Type I and Type II equipment (Figure 1). Changing the state of each data switch in the Type I equipment shall be activated by any one of the following: Restart timer time out (3.10.15.1); CRC detect errors (3.10.16.2); MPS command per ICD 2A; and keyboard entry command. Status of the position of each data switch shall be reported to the MPS. Each change in the position of the data switch which is initiated by a Type I equipment function shall be reported to the MPS; the MPS in turn will send a command to Type II equipment to change a specific data switch. Similarly, when the MPS sends a command to the Type II equipment to change its data switch, a command shall also be sent to the Type I equipment in order that receive modems in the RMS shall operate on the same communications channel. Any time Type I and Type II data switch positions do not agree (change of state condition) a data switch alarm report will be generated by the MPS. This MPS generated alarm will be active until both data switches for a specific Type I - Type II communications link are again utilizing the same communications channel.

3.10.15 Start-up/recovery functions. - Each controller shall be provided the capability to initiate operation of Type I and Type II equipment or to recover after a major failure. During start-up or recovery mode, equipment shall be initialized and ready for operation in any of the other modes when all sequence controls, data tables, and storage (3.8.2) are loaded and operation of control sequences are initiated as further defined below:

(a) Capability shall be provided by sequence control stored in read-only-memory (ROM-3.8.1) to clear all values stored in the last value measured storage areas; to reload, from the MPS the alarm limits, security codes and other applicable information, except data, into assigned RAM storage areas; to initialize the monitor addressing function to index the first monitor scanning point in the defined sequence; and to initialize all buffer storage areas.

(b) Capability shall be provided for start-up or recovery of the controllers, including initialization of ROM and up-link loading of the RAM by the MPS.

(c) Capability shall be provided for switching of the data switch (3.10.14) if start-up/recovery was initiated by a restart timer timeout, the MPS per ICD 2A, or self-test errors (3.10.16.1).

3.10.15.1 Activation. - The start-up or recovery mode shall be hardware initiated by any of the following functions:

(a) Power failure (3.10.4)

(b) MPS initiated per ICD 2A

(c) Restart timer initiated by a hardware implemented sixty (60)-second timer which shall be provided and shall initiate the start-up or recovery mode if not reset by Type I RMS communications with the MPS, and at completion of each synchronous subscan cycle. The restart timer shall be reset continuously when a portable terminal-Type I RMS link has been established.

(d) Manual initiation, local or remote.

(e) Three (3) self-test errors (3.10.16.1).

A start-up/recovery alarm report shall be transmitted to the MPS after the start-up/recovery is completed. This report shall identify the cause of the start-up/recovery activation (Table III).

3.10.16 Error detection. - Type I and Type II controllers shall incorporate self-test functions to detect an equipment-induced subsystem error(s). Cyclic redundancy check (CRC) error detection shall also be provided for all data communications link interfaces between MPS and RMS, and between Type I and Type II equipment. When an error is detected, a "monitor" or "CRC" alarm report (3.6.2.1) shall be transmitted to the MPS as further defined hereunder.

3.10.16.1 Self-test errors. - Equipment shall incorporate monitor fail-safe circuitry to provide both automatic and manual self-test functions. These functions shall be stored in nonvolatile memory as part of the synchronous sampling (3.6.1.2) to detect equipment malfunctions or equipment-induced hardware or firmware errors. As a minimum, automatic and manual error-checking shall be provided for all controller,

storage, and sensor functions to provide a fail-safe monitor design and meet reliability/maintainability (3.11) and performance requirements (3.13). Each self-check error that is detected shall be reported immediately to the MPS as a "monitor" alarm. Upon detecting three (3) errors, the controller shall activate the start-up or recovery mode (3.6.5). Self-test manual diagnostics and built-in test equipment, where required, shall be provided for use with terminal equipment interacting with the equipment controllers to assist in meeting mean-time-to-restore requirements (3.11.2.2).

3.10.16.2 CRC errors. - Equipment shall include provisions for error detection and control of data communications between the MPS and RMS using the CRC technique as specified in ICD 1. The CRC error detection function shall be incorporated in Type I equipment to detect errors in MPS to Type I data communications link, and in Type II equipment to detect errors received in the MPS to Type II link designated as "site 1" or the local interface in Figure 1. The MPS will also incorporate the CRC error detection technique and control functions for the Type I and Type II to MPS data communications links. Upon detection of three (3) CRC errors in consecutive command/control requests from the MPS or a terminal, the following functions shall occur in the order as listed below:

a. Activate the self-test mode - Type I or Type II equipment (3.10.16.1)

b. For Type I equipment, change position of data switch (3.10.14)

c. For Type I equipment, or for Type II equipment at the "local" interface, transmit a CRC alarm report to the MPS.

When the MPS detects three (3) consecutive CRC errors on a Type I to MPS link, the MPS will transmit a command/control message to the Type II equipment over the "local" interface, and also to the associated Type I equipment. Type I and Type II controllers shall respond by changing the position of their data switches for the associated data communications channel.

3.10.17 Multiple MPS operation. - Controllers in Type I equipment shall be designed to interface and operate with up to three MPS, each located at a different ARTCC facility. Protocol, control and queing procedures shall be used as developed by the contractor, approved by the Government, and specified in ICD 2A.

3.11 Reliability and maintainability. - A reliability and maintainability program shall be implemented in accordance with MIL-STD-785 and MIL-STD-470. Maximum utilization shall be made of standard parts and integrated circuits with proven reliability histories. Standard parts are those defined in FAA-G-2100. Where non-standard parts are demonstrated to be necessary in the design, approval shall be obtained from the Government in accordance with FAA-G-2100. Use of commercial quality off-the-shelf assemblies may be used provided they meet requirements of 3.12.9. The RMS shall be designed to be maintained with a minimum of external test equipment and with standard hand

tools. The standard compliment of on-site government-furnished test equipment (3.11.3) may be used to demonstrate maintainability requirements (3.10.16.1, 3.11.2.2, 4.3.1.6). Corrective maintenance shall be effected by replacement of defective modules with subsequent off-line repair of the defective item. The equipment, to the maximum extent possible, shall permit interchangeability, minimize the need for tuning and/or adjustment, and the types of modules, PCBs, etc., used in the RMS. Off-line repair of defective items shall not be included in determination of MTR.

3.11.1 Definitions applicable to Section 3.11. - Reliability and maintainability definitions are those defined in MIL-STD-721, with the additions or modifications as below:

(a) Mean-time-between-failure (MTBF). - The reliability as used herein refers to the functional MTBF of all portions of the RMS which provide any specified function. The functional MTBF does not include panel meters, indicator lamps, etc., if the failure of the component does not impact a specified function.

(b) Mean-time-to-restore (MTR). - The time to restore to an operational condition and meet specified performance requirements of a function or equipment that has failed. The function or equipment may be restored by corrective maintenance, repair by substitution of a module, or PCB replacement.

(c) Failure. - A failure is an equipment or functional failure(s) which causes the complete or partial loss of a specified function; degraded operation of function; deviation from limits of performance requirements; and the erratic, erroneous, or transient operation of any function or equipment.

(d) Service life. - Intended useful life of the RMS. Short life term items are replaced on a scheduled basis under the preventive maintenance plan.

(e) Module. - That element designated as the first level of maintenance required to repair or restore the function to full operational capability.

3.11.2 Reliability and maintainability parameters. - The RMS equipment shall have a service life of 15 years minimum and meet the following reliabiity maintainability numerics.

3.11.2.1 Subsystem reliablity. - Over the range of service conditions (3.12.11), the RMS shall meet MTBF requirements listed below. Numerics are based on each frequency of an A/G radio channel (1.3.12) having a specified MTBF of at least 20,000 hours.

Number of Monitored A/G Radio Channels	Specified RMS MTBF (θ_o)
*1 each one-half channel	at least 20,000 hours
6 each paired channels	at least 2,000 hours *

The above specified MTBF numerics shall include all RMS equipment up to the sensor interface points specified in Table I and functional/performance requirements of this specification. The specified MTBF numerics for a 1 channel through 6 channel RMS in all combinations of split, paired or selective configurations shall be developed by the contractor, based upon the equipment design approach, and submitted to the Government for review/approval at or prior to the initial design review.

Reliability shall be based on preventive maintenance tasks being accomplished at a minimum interval of semi-annually (4320 hours). Switching devices which operate only in response to automatic operation or in response to periodic command by maintenance personnel shall have a minimum specified life of 5,000,000 opeations. Reliability of all other switching devices shall be of such higher value as required to achieve the specified MTBF of the subsystem.

3.11.2.2 Subsystem maintainability numerics. - The mean-time-to-restore (MTR) shall not exceed 0.5 hour with no more than 10 percent of all repairs exceeding 45 minutes and no single repair exceeding 90 minutes. Preventive maintenance time shall not exceed 6 hours per year or 3 hours semi-annually with no task required to be accomplished more frequently than semi-annually for the maximum size subsystem (Table I).

3.11.3 Test equipment. - All required maintenance and calibration tasks shall be capable of accomplishment utilizing only the additional built-in test equipment (BITE) and diagnostics as may be required by the contractor's design, and the following (GFE) standard test equipment items which shall be assumed to be available at the RCAG or ARTCC facility.

(a) RF load, 50 ohm 500 watt, Bird 8201, or equal

(b) Audio power meter, General Radio GR-1840, or equal

(c) Communications Service Monitor, Singer CMS-1, or equal (includes oscilloscope, 10 MHz counter, 100 MHz transfer oscillator, AM percent modulation and audio test tones)

(d) Functional power meter, 0 to 250 watt, Bird model 440, or equal (includes VSWR)

(e) Function generator sine/square wave, DC to 3 KHz, Clarke-Hess No. 738, or equal

(f) Oscilloscope, Ballentine 1066B, or equal

(g) Portable terminal (see paragraph 1.3.18)

3.11.3.1 Standard and built-in test equipment list. - In accordance with the contract schedule, an itemized list of the required GFE standard test equipment and contractor furnished BITE (to meet maintainability requirements of 3.11.2) shall be provided

by the contractor. The list shall describe the required main and functional characteristics of each item. Accuracies of each item shall also be listed along with the parameters that are to be measured.

3.11.3.2 Maintenance tools list. - In accordance with the contract schedule, the contractor shall supply a complete list of all tools, standard and special, required for maintenance and repair of the RMS. Special tools shall be provided with the equipment as part of the basic contract. Common tools shall be adequately described for easy identification and procurement by the government. Special tools are defined as tools required for maintenance of the RMS and are not available as a standard catalog item from any manufacturer.

3.11.4 Reliability program. - The specified reliability (3.11.2.1) shall be achieved through a reliability program performed in accordance with MIL-STD-785 and the following:

(a) MIL-HDBK-217 and revisions thereto shall be utilized as required by MIL-STD-785.

(b) The contractor shall perform a reliability modeling task of the proposed design for the equipment to determine compatibility with the required MTBF. A failure rate shall be assigned to each part of the equipment at an environmental condition of 50°C input air using data presented in MIL-HDBK-217. Parts not included in coverage of MIL-HDBK-217 shall use the failure rate of the most similar part in the coverage. Where this is unrealistic, any valid existing data may be used with the approval of the Government.

(c) The contractor shall conduct a failure modes, effects, and criticality analysis (FEMCA) task down to the module replacement level in normal maintenance. (e.g., printed circuit card, power supply module, modem). For each replaceable item, the dominant mode of failure shall be determined to ascertain the effect on the subsystem, and also separately for Type I equipment and Type II equipment. The analysis shall be used to evaluate and change the reliability/maintainability model, if necessary. The FEMCA task shall be used in preparation of the maintainability demonstration tasks.

(d) The above reliability and maintainability tasks shall be submitted to the Government for review at or prior to the initial design review. Where predicted figures are less than requirements, the contractor shall accomplish such design changes as necessary to raise the predicted MTBF to the value specified. The analyses shall be revised periodically to reflect changes in design as they occur and/or when better data is available on part failure rates. An update of the reliability and FEMCA analysis shall be submitted at the critical design review.

(e) As the fabrication of each module of the equipment is completed and nominal equipment operation is possible, the contractor shall prepare and submit to the Government a final prediction of equipment and subsystem reliability. If the prediction is less than the required reliability, the contractor shall accomplish changes in design, part application and part stress as necessary to reduce the final indicated equipment failure rate to an acceptable level.

3.11.5 Maintainability program. - The required maintainability (3.11.2.2) shall be achieved through a maintainability program performed in accordance with MIL-STD-470. Terms and definitions for maintainability not otherwise described herein shall be in accordance with MIL-STD-721. All electronic and mechanical equipment shall be designed and constructed to minimize skill, experience and time necessary to disassemble, assemble and maintain them. Corrective maintenance shall utilize a remove-and-replace concept with actual repair of the replaced module to be accomplished later in a separate maintenance area.

3.12 Equipment design and packaging. - The equipment shall be designed, configured and packaged in such a manner as to facilitate all test, adjust and maintenance activities to be performed either from the front or top access to equipment when installed in an equipment cabinet-type rack. All components of Type I equipment at the RCAG shall be housed in one (1) cabinet, and not more than three (3) cabinets shall be required for the maximum size Type II equipment configuration at the ARTCC. All unused front panel space shall be covered by blank panels.

3.12.1 Equipment cabinet. - The equipment cabinet shall be a cabinet-type rack accommodating standard 19-inch panel units per Dwg. D-21140 of FAA-G-2100/1. The cabinet shall be the equivalent in equipment mounting space, quality of materials, construction methods and finish to the solid-sided cabinet rack described in FAA-E-2672 but which may differ in non-essential detail. The following are essential requirements through reference to FAA-E-2672 and FAA-G-2100/1.

(a) The cabinet shall accommodate any combination of standard 19-inch panel units (Dwg. 21140) up to 70-1/8 inches for Type I equipment and 77-1/8 inches for Type II equipment.

(b) The maximum height, width and depth dimensions shall be as follows:

RMS	FAA-E-2672
Type I equipment	Type II cabinet rack
Type II equipment	Type III cabinet rack

The optional top panel (3.4.4), grounding strip (3.4.6) and a grounding-type duplex convenience outlet shall be provided and mounted on the front of the cabinet at the bottom.

(c) Dimensional and angular tolerances and structural rigidity shall be such that when a full compliment of equipment is installed in the cabinet, there shall be no interference in the smooth operation of the slide-mounted units, including when units are withdrawn to their full extent. Holes in the bottom shall be made for bolting the cabinet to the floor.

3.12.2 Unit construction. - Each equipment unit shall be a panel chassis unit designed and contructed for sliding into and out of the rack on heavy duty roller-type drawer slides. The slides shall be provided with latching stops to limit the travel of the

chassis to that sufficient for complete access to the components, and by intentional unlatching of the stops, to permit complete removal of the chassis from the rack. It shall be possible to roll the chassis out of the rack to the limit of travel without any leads or cables becoming disconnected or damaged or without the necessity of disconnecting any leads to permit full forward travel of the chassis. The leads and cables shall be so positioned that the chassis can be rolled back into the rack without interference with the movement and without damage to the leads and cables. Cable supports or carrriers, as necessary to meet this requirement, shall be provided; however, rubber band or spring-type supports shall not be employed.

3.12.3 Modular construction. - Modular construction with plug-in or easily replaceable chassis-type modules/subassemblies shall be employed throughout the equipment. Modularization shall be based on a logical functional block concept (3.4.4, 3.4.5). Design shall be such as to minimize the average cost and number of different types of modules required for supply support. It is not intended that the modules be contained in separate drawers, but rather on individual printed wiring board(s), chassis type modules, or subassemblies. All modules shall be accessible from the top or front of each drawer.

3.12.4 Printed wiring boards. - Except for critical application and for controls or components specified to be located elsewhere, or where demonstrated to be impracticable from the standpoint of parts size or weight, all circuit parts shall be mounted on printed wiring boards in accordance with FAA-G-2100/4. All printed wiring boards, components and wiring shall be accessible from the top side of all drawers. Components too large or too heavy to be mounted on printed wiring boards shall be mounted on easily replaceable subassemblies. One extender board of each type required shall be furnished as a part of the set of equipment to be provided to each site.

3.12.5 Chassis-type modules. - Chassis-type modules or subassemblies shall be used where printed wiring boards are impractical. One extender cable of each type required shall be furnished as a part of the set of equipment to be provided to each site.

3.12.6 RF modules. - RF modules shall be printed wiring boards except where such practice is not consistent with performance requirements. RF modules shall be plug-in except that feed-through screw-type connectors may be used for RF interconnection. Tuning controls shall be readily accessible when the modules are in place. Where necessary to provide unrestricted access to all components for troubleshooting purposes, extender cable(s) shall be furnished. One extender cable of each type required shall be furnished as part of the set of equipment to be provided to each site.

3.12.7 Solid state circuitry. - All active circuitry shall use semiconductor devices in accordance with FAA-G-2100/3. Micro-electronic devices and micro-processors and micro-computers shall be in accordance with FAA-G-2100/5. With the exception of the relays specified in 3.6.3.5, electro-mechanical devices shall not be used. Also, tubes shall not be used.

3.12.8 Controller design. - The controllers required for Type I and Type II equipment shall be selected from a family of "off-the-shelf" micro-processor/micro-computers. The government envisions that the Motorola series 6800 micro-processor or equal, which can be operated in either an 8-bit word or a 16-bit word, as being a potential design which can be adapted by software/firmware to meet the functional requirements of this specification. However, the contractor shall select the actual micro-processor/ micro-computer to be utilized for the RMS and submit his recommendations to the government for review/approval at or prior to the initial design review. Essential criteria that shall be met in selection of the controller devices are as follows:

Controller Selection Criteria

(a) EIA-RS-232 and EIA-RS-449 interface compatibility.

(b) ANSI X 3.4 ASCII code compatibility.

(c) Capability for IEE-STD-488 programmable instrumentation.

(d) Operation with either an 8-bit word or 16-bit word configuration.

(e) I/O bus - refer to Figure 1 for functional criteria.

(f) Random-access-memory, 1K word storage expandable in 1, 2 or 4K increments to 16K maximum.

(g) Read-only-memory, 1K word storage expandable in 1, 2 or 4K increments to 16K maximum.

(h) Memory cycle time of 850 nanoseconds, maximum.

The above criteria are being imposed on the contractor by the government with the objective of establishing a standard family of controllers to be used in subsequent equipment procurements which may be procured and will specify use of micro-processors/ micro-computers. There may be additional criteria that are necessary to be incorporated in the selection criteria to meet requirements stated herein, or additional recommendations by the contractor that should be included. These shall be included in submission at or prior to the initial design review.

3.12.9 Use of commercial equipment. - The contractor may elect to use commercially available "off-the-shelf" equipment, subject to the constraints in the following subparagraphs.

3.12.9.1 Definition of commercial equipment. - Commercial equipment used in the RMS defined as follows:

(a) Are not intentionally designed to meet FAA-G-2100/1, -3, -4, or -5.

(b) Are a standard product line or "off-the-shelf" catalog-listed items, available at the time of proposal submission from 2 or more suppliers.

(c) Have published technical descriptions and operational environment characteristics.

(d) Have supporting instruction manuals for theory of operation, user procedures, maintenance repair, logistics support and detailed troubleshooting procedures which incorporate the essential requirements of FAA-D-2494/1 as specified in 3.18.1.

3.12.9.2 Request for approval. - Use of any commercial item in the RMS shall be justified and processed by the RFA procedures defined in FAA-G-2100 for non-standard items. Government consideration will be given for use of commercial equipment proposed by the contractor, under the following general guidelines:

(a) The item is not available to fit the specified requirement; and

(b) Use of the item shall not compromise the functional, reliability, maintainability and performance and service condition requirements of this specification.

3.12.10 Design center values. - (See 1-3.2.23(a) of FAA-G-2100/1). For Type I and Type II equipment, the primary power source shall be 120 VAC, single phase, 60 Hz. Additionally, all Type I equipment with the exception of the required AC power supply and cabinet convenience outlets shall be designed to operate from a battery bank with a DC output range from 22 to 30 volts (modifies DC voltage requirements of 1-3.2.23(a) of FAA-G-2100/1) and with AC ripple across the DC supply up to a level of 100 MV rms. Isolation from the battery bank and associated charger circuitry (a government-furnished future option) shall be provided to permit uninterrupted operation of Type I equipment in the event of failure of the AC power source at the RCAG site. Terminals shall be provided on Type I equipment for connection to the future DC power source. When this type of power source is implemented, the AC power supply in Type I equipment will be disconnected from the load circuits.

3.12.11 Service conditions. - (See 1-3.2.23(b) of FAA-G-2100/1) For Type I equipment, ambient conditions shall be ENVIRONMENT IL For Type II equipment, ambient conditions shall be ENVIRONMENT I.

3.12.12 Crosstalk, shielding, isolation and grounding. - Arrangement of parts, wiring and design of the equipment shall be such that crosstalk and unnecessary coupling between circuits cannot result in conditions of operation which are beyond the values allowed for specified performance characteristics. Grounding, bonding and shielding shall meet requirements of FAA-STD-020. Adequate shielding and other means of isolation shall be provided as necessary to prevent the occurrence of significant changes in signal levels, waveforms, timing, tuning, or operating conditions with any combination of open access doors, withdrawn chassis, and with extender units (3.12.4, 3.12.5, 3.12.26) in use. Also, the positioning of wires or cables shall not affect the operating conditions or performance of the equipment. In addition to the aforementioned requirements, sufficient shielding, decoupling and filtering shall be provided to prevent interference to or from existing RCAG A/G communications equipment (1.3.2, 1.3.3) operating in the frequency bands of 118 through 136 MHz and 225 through 400 MHz. This requirement shall be with RF power outputs up to 65 watts and located within one foot of the equipment furnished under this specification.

A/G receivers have ATC operational requirements for conducting satisfactory communications with a squelch threshold sensitivity down to -98 dBm.

3.12.13 Lightning and transient protection. - Equipment shall be protected against damage due to lightning surges on the incoming AC power lines and landlines in accordance with FAA-STD-020. For design and test purposes, the contractor may assume that the facility is provided with AC power surge arrestors installed across each line to neutral at the facility main service disconnect box in accordance with requirements of FAA-STD-020. These arrestors limit the transient voltage waveform appearing on the AC power source to 1,000 volts, with a rise time of 10 microseconds and a decay time to one-half amplitude of 20 microseconds. (See paragraphs, 1-3.3.3, 1-3.3.4 and 1-3.3.5 of FAA-G-2100 for AC over voltage and under voltage transient protection requirements.)

3.12.14 Modification to FAA-G-2100/1. - In paragraph 1-3.3.5, line 3, change "4 milliseconds" to "10 milliseconds".

3.12.15 Printed wiring boards. - All printed wiring boards shall be of the plug-in type and shall be mechanically coded and keyed in such a manner that only properly coded boards can be inserted.

3.12.16 Tests points and connectors. - Each equipment shall contain test points and connectors, appropriately labeled and numbered, as necessary to provide for the examination of significant voltages, signal amplitudes, waveforms and timing characteristics, and to provide for the connection of test equipment (3.11.3) for adjustment and maintenance operations. The type of test points and connectors provided shall be compatible with the applications for which the test points and connectors are needed. All test points and connectors shall be accessible with adequate visibility and clearance from adjacent objects to permit safe and unhampered connection of cables and probes. Connection to test points and connectors utilized in either adjusting or testing the equipment for proper performance shall not necessitate interrupting operation of on-line A/G equipment. Test points on plug-in printed wiring boards shall be located on the outside edge of the board.

3.12.17 Access to controls and wiring. - All controls which may require adjustment in the conduct of test, measurement and operations necessary to achieve the performance required shall be accessible from the front of each equipment unit or shall be immediately available from the top of the unit upon withdrawing the sliding chassis. All input/output wiring shall be accessible behind a front panel access cover(s). Removal of drawers shall not be required for access to any input/output wiring.

3.12.18 Crystals and crystal ovens. - All frequency determining crystals shall be plug-in type. Use of crystal ovens shall not be permitted.

3.12.19 Module plug-in/removal placard. - Modules which cannot withstand the transient voltages encountered when being plugged-in or removed from the equipment without first removal of power from the equipment shall be prominently identified with a caution notice being placed in the instruction book and in the area immediately adjacent to the module(s).

3.12.20 Cabinet and unit prewiring.- Cabinet and equipment units shall be pre-wired to accommodate the modular expansion from the basic subsystem sizing requirements (3.4.4, 3.4.5; Table I, Table II). All cables and wires, harnessed or single, shall be protected against chafing, where required, and such protection shall be independent of the individual wire, cable insulation, or jacket. Cabinet cabling to exterior interfaces or inter-unit cabling between cabinets for Type II equipment shall enter and exit through the top. Direct cabling through the side wall of cabinets in Type II equipment, at least six inches above the floor, may be utilized where distance is considered a critical factor by the contractor in circuit performance. Direct cabling shall not in any way compromise the requirements for modular expansion. Cable entrances and exits on cabinets shall be provided with cover plates, where required. Detailed requirements covering the contractor's Site Installation of RCAG RMS equipment are incorporated in the contract schedule.

3.12.21 Cabling interface distance.- Type I and Type II equipment shall meet the requirements of this specification for equipment cabling distances up to 100 feet from interface to sensor points (Table 1). The interface cabling distance between modems in Type II equipment and the MPS shall be up to 300 feet. Cabling and installation thereof for all external/interfaces shall be provided by the contractor.

3.13 Subsystem performance.- The equipment shall meet the functional and performance requirements of this specification when aligned, adjusted, and calibrated in accordance with procedures in the RCAG RMS instruction manual. Unless otherwise specified, all functional and performance requirements shall be met over the range of service conditions (3.12.11).

3.13.1 General.- Except where otherwise indicated, functional characeristics and requirements in this specification for each monitored parameter and command/control signal, each voice frequency (VF) channel, each pilot tone signal, and RMS data signal are stated in terms of subsystem performance requirements as measured between input and output (I/O) external interface terminals for Type I and Type II equipment which are interconnected by the required private line communications channels (3.4.3.3, 3.4.3.4). Subsystem link control and protocol procedures shall be as specified in 3.4.3.1 and 3.4.3.2. Specific communications channel interface parameters shall be as specified in 3.10.11. Performance requirements shall be met while simultaneously transmitting voice or performing control/signal functions between external VFCS equipment that are interfaced with the RMS equipment in a subsystem configuration.

3.13.2 VF communications channel.- When RMS equipment is interfaced and operated simultaneously with the VFCS equipment, the following subsystem transparency requirements shall be met (3.10.2).

3.13.2.1 Channel loading.- The bridging across or insertion of required RMS equipment in the VF communications channel shall not change end-to-end insertion loss or alter the send/receive signal levels associated with operation of the VFCS equipment * by more than 0.5dB. *

3.13.2.2 Frequency response. - Over the range of 300 to 2400 Hz and 2750 to 2860 Hz, the RMS equipment shall not modify the end-to-end frequency response of VFCS equipment by more than 0.5 db.

3.13.2.3 Hum and noise.- Over th range of 300 to 3000 Hz, the RMS equipment total contribution of additional hum and noise (steady state or impluse) to the end-to-end VF communications channel shall not exceed a level of -65 dBm.

3.13.2.4 RMS crosstalk. - Pilot tones and data signals in the Type II-to-Type I communications channel link shall be no greater than -65dBm when measured at the the Type I equipment external interface (Figure 1) to the VFCS receivers (FAA-E-2431) for the 2400 Hz low pass filter, the AM filters for each of the five(5) specified frequencies, and 2805 Hz band pass filter for frequency shift signals. Pilot tones and data signals in the Type I-to-Type II communications channel link shall also be no greater than -65dBm when measured at the output of the filter in Type II equipment which provides audio from the A/G receivers at the RCAG to equipment at the ARTCC.

* 3.13.2.5 VFCS equipment end-to-end delay. Over the range of 590 to 2850 Hz, the contribution of RMS equipment to the delay of end-to-end transmission of AM tone and FSK signaling shall not exceed 5 MS. *

3.13.3 Throughput timing. - Subsystem response times to automatic and manual command/control and monitoring functions shall not exceed the following limits:

	Function	Limit
(a)	Alarm reports (3.10.9.1)	2.5 seconds
(b)	Subsystem interaction time (3.10.9.4)	0.5 seconds
(c)	Man-machine interaction (manual)	In accordance with 3.10.9.5
(d)	Startup/recovery (3.6.5)	60 seconds

3.13.4 Stability. - Variations in equipment transmitting and receive levels due to temperature/circuit changes, circuit-component aging, amplifiers drift and the like shall be maintained sufficiently stable over a 6-month period (4320 hours) to preclude the need to perform adjustments or calibrate the equipment.

3.13.5 Monitored parameter accuracy. - The subsystem error for all monitored parameters using GFE sensors (3.2) shall be reported within 3 percent of the derived value obtained * from the sensor output interface (Appendices 1 through 5). Excluding VSWR associated with LPA operation (3.5.2.4), the subsystem error budget for monitored parameters using contractor-furnished sensors shall be within *

8 percent of the actual value. For purposes of meeting requirements for contractor-
*furnished sensors, the output level at sensor interfaces (excluding the LPA reverse power sensor) shall be within 5 percent of the actual value; and the remaining 3 percent of error budget shall be allocated to RMS subsystem inaccuracies. The output level at the LPA reverse power sensor shall be within 10 percent of the actual value. *
Subsystem error budget for LPA VSWR shall not exceed 13 percent.

3.13.6 Data transmission error rate. - In the "Speech plus data" mode of operation (3.4.1), the bit error rate for data transmissions between the input/output interfaces of Type I and Type II equipment shall not exceed 1×10^{-5} for each 96 hours of continuous operation. These requirements shall be met with a signal-to-noise ratio as low as 10dB. For this requirement, noise shall consist of C-message weighted noise and interference signals from voice communications and VFCS signals that may exist in the 2450 to 3000 Hz frequency band. This error rate requirement is exclusive of the error control requirements (3.10.16.2).

3.13.7 Subsystem errors. - In responding to either automatic or manual command/control requests for the required function and meet performance requirements of this specification, not more than one (1) error generated by RMS equipment shall occur for each 360 hours of continous operation. Subsystem errors shall include but not be limited to the following:

(a) Errors resulting from degradation in circuit or equipment performance which are undetected (3.6.6)

(b) Failure of a controller mode (3.6) to function in the specified manner.

(c) False alarms reported for a monitored parameter whose value does not actually exceed the alarm threshold setting.

(d) Failure to perform the specified pre-alarm filter (3.10.5), alarm correlation (3.10.6), RF power sampling (3.10.7), S+N/N sampling (3.10.8), parameter limiting (3.10.10), error detection (3.10.16), or multiple MPS operation (3.10.17).

(e) Errors resultilng from crosstalk or interference signals that are encountered during voice communications or normal operation of external VFCS equipment.

3.14 Preproduction subsystem. - When specified in the contract schedule, a preproduction or prototype RMS shall be installed at the FAA Academy, Oklahoma City, Oklahoma. The primary purpose of the Academy subsystem will be to provide a simulation and training capability for RMS. A Type I equipment, six channel complement consisting of two (2) paired channel, two (2) split channel, and two (2) selective channel configurations shall be provided. The preproduction subsystem shall meet all requirements of this specification. Additional unique requirements that may be imposed on this subsystem will be set forth in the contract schedule.

3.15 Site spare printed circuit cards. - In accordance with the contract schedule, the contractor shall supply spares as a kit to each ARTCC site and RCAG site, a number of printed circuit cards equal to 8 percent of the total quantity of each type used in equipment at each site. Spare quantities shall be furnished separately as a kit with Type I equipment and with Type II equipment to each RCAG site and to each ARTCC site, respectively. Total quantity furnished to each site shall not exceed 4 or less than 1 of each type card used at a site. If the 8 percent quantity results in a fraction, the next higher whole number shall be provided. Spare PCBs shall be furnished as a complete set for the RMS configuration and be available at each site at the time of completion of subsystem on-site tests and Joint Acceptance Inspection (JAI) by the government. Other additional site spare parts, central depot spare parts, or both shall be provided in accordance with the contract schedule.

3.16 Site installation, checkout, and integration. - The contractor shall submit to the government for review/approval a master plan which details the specific approach, methodology and procedures to be followed during installation, checkout, and integration of RMS equipment with MPS equipment. The plan shall include the methods, equipment and government coordination/support required to ensure an orderly and preplanned set of guidelines that the contractor shall follow during all phases of installation. The plan shall be submitted as separate documents, one being the master installation plan and the other the RMS checkout and integration plan with MPS. The government's general requirements concerning installation criteria of RMS equipment at RCAG and ARTCC sites are included in the contract schedule.

3.16.1 Site project officer. - At least four months prior to schedule time for start of installation at each site, a site project officer for that specific site(s) will be designated by the government to function as the government coordinator for all installation, checkout and integration activities. Site activities shall not commence by the contractor until coordinated with the project officer.

3.16.2 Site installation constraints. - All required equipment shall be on site before start of installation. When required, limited space will be available at each site for storage of RMS equipment shipped to the site. Parking space and electric power will be provided at the ARTCC site by the government for one (1) contractor-furnished office trailer during the installation at the ARTCC site. When an A/G channel is released by the government to the contractor, work shall commence promptly and continue on that channel until completion so that the "out-of-service" time for each channel shall be held to one (1) hour maximum. Only one channel will be released by the government to the contractor at any given period of time.

3.16.3 Site adaptation source data. - At least 60 days prior to scheduled delivery at each site, the government will provide an update on any changes to source data since award of the contract.

3.16.4 RMS integration with MPS. - The contractor shall conduct checkout tests with the RMS equipment after being installed to verify proper equipment operation and that no damages/changes to equipment have been encountered after factory tests and shipment to the site. Upon completion of equipment checkout, integration tests with the MPS shall be performed to verify subsystem functions and performance in the RMS-MPS operational environment.

3.16.5 Joint acceptance inspection (JAI). - Equipment installed at each RCAG site and ARTCC site shall be subjected to on-site tests (4.4) and individual JAI by the contractor and government. The government will be represented by technical and/or program personnel and by a Contracting Officer's representative as part of the JAI. The contractor shall demonstrate that the installation and equipment operation meets the requirements of the contract.

3.17 Subsystem design reviews. - The contractor shall plan for design review meetings throughout the design phase of the contract as well as conduct initial design review and critical design review conferences. The initial design review shall be conducted within three (3) months after contract award. The critical design review shall be held within seven (7) months after contract award. Design data shall be submitted at each review. Reports on the design reviews shall be prepared by the contractor and forwarded to the contracting officer for review. The design reviews shall not be a vehicle for the contractor to introduce proposed changes to the requirements of this specification.

3.18 Documentation. - The following documentation shall be provided.

3.18.1 RMS subsystem instruction books. - RMS subsystem instruction books in accordance with FAA-D-2494/1 and FAA-D-2494/2 shall be provided with each equipment and firmware furnished to an ARTCC facility and RCAG site. Quantities required shall be in accordance with the contract schedule. In the event the Government approves the use of commercial equipment (3.12.9), the contractor may elect to also propose furnishing a commercial type instruction book or portions of commercial books that is supplied with the approved commercial equipment. Use of each type of commercial instruction book shall be approved by the Government. To be a candidate for approval, the commercial book shall include as a minimum the equivalent information and level of detail required in FAA-E-2494/1, Sections 4, 5, 6, 7, and 8. In any event, the RMS subsystem instruction books shall be provided and portions of commercial-type book(s) if approved, shall be integrated into the text.

3.18.2 Micro-processor/micro-computer programs. - Complete documentation of all micro-processor/micro-computer programs and firmware program specifications for the RMS shall be provided and delivered in accordance with the contract schedule. Documentation shall include a computer program organizational specification (CPOS), computer program functional specifications (CPFS), performance specifications, program flow charts, and program listings. The CPOS shall include a detailed description of the overall subsystem program organization with a breakout for Types I and II equipment, the executive program structure, interrupt scheme, the input/output concept, and all program segments including detailed processor timing, and program and data storage allocations. The CPFS shall be provided for all program segments and include detailed functional definition of each operation performed, a detailed definition of all data parameters, and a detailed definition of all interfaces and their parameters. Performance specifications shall be provided for all programs and shall include a detailed specification of each performance parameter and the design tolerances on each performance parameter. Detailed flow charts and a complete program listing of the instructions, in the highest level language in which the program is written,

shall also be furnished. Flow charts, functional specifications, performance specifications, and program listing shall be cross-referenced so as to provide ease of determination of where and how all specific and general requirements are met. The program listings shall consist of an annotated side-by-side listing of the highest level language codes utilized in implementing the operational program.

3.18.3 As-built site installation drawings. - Two (2) sets of red-lined "as-built" site installation drawings covering all equipment installed at each site shall be provided. These drawings shall include power distribution cabling, signal and control cables, transmission cables, ground systems, floor plan, and equipment identification. One set of on-site, red-lined "as built" drawings shall be provided to the Government prior to system acceptance at each site. The other set of red-lined "as-built" drawings shall be provided to the project officer within 10 days after Government acceptance at each site.

* 3.18.4 ROM burn-in. Documentation shall incorporate all factory implementation procedures used and required for "burn-in" of data in the read-only-memory (ROM). This information shall be comprehensive to the extent that it will be used by the Government to modify ROM data at some future time subsequent to delivery and acceptance of equipment at a site. *

3.19 GFE A/G and VFCS equipment. - When specified in the contract schedule and requested by the contractor, the following government furnished equipment with associated instruction manuals will be shipped FOB destination to the contractor's plant for use during the design phase and factory test demonstrations with RMS equipment.

Item	Quantity
(a) T-1108/GRT-21 VHF exciter	12 each
(b) AM-6154/GRT-21 VHF LPA	2 each
(c) T-1109/GRT-22 UHF exciter	12 each
(d) AM-6155/GRT-22 UHF LPA	2 each
(e) AN/GRR-23 VHF receiver	12 each
(f) AN/GRR-24 UHF receiver	12 each
(g) VFCS equipment	8 sets
(h) RF body (power sensor)	12 each
(i) Coaxial relay	24 each
(j) Cabinet racks	18 each

The above equipment complement will permit the contractor to interface and conduct tests with A/G radio channels and associated VFCS equipment. Interfacing RMS equipment can be configured as a six-channel subsystem; two channels being paired, two channels being split, and two channels being selective with on-line and off-line units for each channel. One channel will be configured for 50 watt operation. At completion of the contract, this GFE equipment shall be returned by the contractor FOB destination to the government's central depot at Oklahoma City, Oklahoma. A/G equipment shipped to the contractor's factory shall be installed by the contractor in GFE racks/cabinets in accordance with drawings to be provided by the Government. The contractor shall provide all interunit wiring.

4. QUALITY ASSURANCE PROVISIONS.

4.1 General.- See section 1-4 of Specification FAA-G-2100/1. The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013, Quality Control Program Requirement.

4.2. List of subsystem tests. - The contractor shall prepare the lists of tests, the test procedures, and the blank test data forms in accordance with FAA-STD-013. A list of subsystem tests shall be submitted initially with the initial design data for government review and approval. The detailed test procedures and blank test forms shall be submitted with the final design data at the critical design review for government review and approval. The lists of tests, the detailed test procedures, and the blank test data forms shall be submitted in two categories: (a) Factory tests, and (b) On-site tests.

4.3 Factory tests. - Factory tests fall into three general categories; Subsystem Design Qualification Tests, Type Tests, and Production Tests. All factory tests shall be successfully completed before equipment is shipped to the ARTCC and RCAG locations specified in the contract schedule for on-site tests. The number of Type I and Type II RMS equipment to be subjected to type tests in a subsystem configuration shall be based on the contract quantity for each equipment type and the type Test Groups listed in FAA-G-2100, paragraph 1-4.3.3.1 and Table I therein. For example, if 106 Type I equipment and eleven Type II equipment are the contract quantities, a total of four (4) type tests of the subsystem will be conducted. Two (2) of these type tests will be performed with both Type I and Type II equipment subjected to the environmental test procedures per FAA-G-2100, paragraph 1-4.12; and four (4) of these type tests will be conducted while subjecting only Type I equipment to the environmental test procedure.

4.3.1 Subsystem design qualification tests. - This testing shall demonstrate compliance with all functional and performance requirements of this specification (Sections 3 and 4), and with the requirements of FAA-G-2100/1, paragraph 1-4.3.2. Tests described in the following subparagraphs, except where noted otherwise, shall be conducted with Type I and II RMS equipment inter-connected with simulated private line communications channels with provisions included for varying channel parameter characteristics over the ranges specified. Simulated private line communications channels shall have characteristics as specified in FAA-S-1142 and Type 2002 channels per AT&T Technical Bulletin No. 43201. Type II equipment shall be interfaced and operated with simulated MPS functions in accordance with ICD 1 and ICD 2A.

4.3.1.1 Capacity and performance tests. - A subsystem capacity and performance test shall be conducted with the maximum size subsystem (Table I) that is configured to monitor six (6) A/G radio channels, all pilot tone signals, and the environmental and security sensor points. The subsystem shall be operated over the range of service conditions for a period of at least 96 hours to demonstrate all functional and performance requirements of paragraphs 3.5 through 3.10, 3.12 and 3.13. The subsystem shall be interfaced with VFCS equipment. Exciters for each A/G channel shall be randomly keyed (PTT) at a rate of approximately 100 per hour or 2400 per day. Failure of the equipment to perform one or more required functions as specified or meet performance requirements is a subsystem failure to meet the requirement of this subparagraph.

4.3.1.2 RMS to multiple MPS interface. - Subsystem tests shall be conducted with Type I equipment configured to monitor six (6) A/G channels and associated Type II equipment interfaced to three (3) simulated MPS. The six channels shall be

separated into groups of two each and operated with three separate test fixtures, each simulating an MPS interface. Tests shall be conducted to verify compliance with functional and performance requirements.

4.3.1.3 RMS to MPS tests. - Tests shall be conducted with Type I equipment at the contractor's factory and inter-connected with Type II equipment located at an MPS facility using private line communications channels in accordance with FAA-S-1142 and Type 2002 channel parameters. The RMS equipment shall be interfaced and operated with the VFCS equipment. The contractor shall ship the equipment FOB destination to the location specified by the Contracting Officer. The contractor shall lease the required communications channels and be responsible for coordination of test activity with the MPS contractor. Operational tests shall be conducted to verify RMS functional and performance requirements when interfaced and operated with the MPS.

4.3.1.4 Reliability and maintainability test plans. - The contractor shall document the formulation and implementation phases of the reliability and maintainability test programs in accordance with the requirements hereunder. Documentation shall include data record forms, complete in all relevant detail, and submitted to the Government for approval.

4.3.1.4.1 Documentation required for the formulation phase. - Documentation for the formulation phase shall include the following:

(a) Contractor's proposed demonstration plan and management organization.

(b) Complete description of demonstration test plans, analytic models, and reliability analysis.

(c) Complete description of the data reporting system with a description and samples of data reporting forms.

(d) A milestone chart and planned work schedule indicating the time required to demonstrate the various phases of the demonstration requirements.

4.3.1.4.2 Documentation required for implementation phases. - Documentation for this phase shall consist of the following:

(a) Progress reports are to be submitted at bi-monthly intervals with milestone charts showing the planned work schedule and work completed. The contractor's management shall ensure that these reports are consistent with the objectives and plans described in the formulation phase of the demonstration test program.

(b) Final report covering the completed contract shall contain as a minimum:

1. Data collected.
2. Factors which influence data.

3. Analysis of the data (data reduction technique used, use of the data by the analytic models).

4. Results of the demonstration.

4.3.1.5 Reliability demonstration test program. - The contractor shall design and implement a reliability test program to demonstrate compliance with the specified MTBF requirements of 3.11. The specified MTBF of 2,000 hours for a 6 paired channel subsystem configuration is the upper test MTBF (0_0) that shall be used for the reliability test specified in MIL-STD-781 to demonstrate an acceptable value of MTBF. The lower test MTBF (θ_1) for an unacceptable MTBF is 1000 hours. The demonstration shall be performed with equipment subjected to a thermal stress of 40° C and electrical stress for fixed ground equipment in accordance with Table I and statistical Test Plan IV C of MIL-STD-781, providing nominal decision risks of 20 percent and a discrimination ratio of 2.0. Throughout the demonstration, the RMS equipment shall be exercised in a test program of monitoring external sensors and operating with interfacing VFCS equipment.

4.3.1.6 Maintainability demonstration test program. - The contractor shall design and implement a maintainability demonstration test program such that the probability of the governmen accepting an equipment that does not meet MTR requirements does not exceed 0.1. The contractor shall design plans whereunder fault simulation for corrective maintenance tasks shall be performed by the introduction of faulty parts, deliberate misalignment, and "bugging" as specified in MIL-STD-471. A minimum of 50 stratified (bugged) samples are required for developing time-to-restore data. Preventive maintenance will not be charged against MTR. Further, the contractor may assume that time-to-restore data will not include logistic delay, i.e., maintenance personnel, parts, and tools are available at the site. The contractor shall demonstrate MTR (Corrective maintenance) by applying Method 4 (90 percent confidence) from MIL-STD-471 using the fault simulation time-to-restore data.

4.3.1.7 Failure to meet reliablity/maintainability test requirements. - Failure to meet the respective reliability/maintainability numerics of 3.11.2 during demonstration tests shall require corrective action by the contractor, at no additional cost to the government, and restart from zero time of those demonstration tests, i.e., MTBF and MTR for which compliance was not established as a result of previous tests under the demonstration program. However, in the event corrective actions effect reliability/maintainability requirements satisfied under previous tests, the contractor shall, at no additional cost to the government, upon written request from the government, repeat those demonstration tests so effected.

4.3.2 Type test. - Type test shall be conducted per FAA-G-2100/1, paragraph 1-4.3.3. The contractor shall submit to the government for approval a list of proposed type tests in two categories; those to be conducted under normal environmental conditions, and those to be conducted under service conditions. The service conditions shall be as specified in 3.12.11. The minimum complement of RMS equipment shall consist of all units required to monitor all parameters (Table I) associated with a two (2) channel A/G configuration.

4.3.3 Production tests. - Production tests shall be conducted on all subsystems per FAA-G-2100/1, paragraph 1-4.3.4. The contractor shall submit to the government for approval a list of proposed production tests in two categories; those to be conducted as a subsystem configuration, and those to be conducted on Type I and on Type II equipment.

4.4 Subsystem on-site tests. - As a minimum, the tests listed hereunder shall be conducted at each site. All required documentation shall be on-site at the start of tests.

4.4.1 External interfaces. - Operation with the following shall be verified:

(a) Interface with all private line communications channels provided by the Government.

(b) Interface with the MPS per ICD 1 and ICD 2A.

(c) Interface with the portable terminal per ICD 1 and ICD 2A.

(d) Compatibility of subsystem grounding with grounding system at installation site.

4.4.2 Functional and performance tests. - The following subsystem functional and performance tests shall be conducted:

(a) Operational tests with VFCS equipment in the speech plus data mode.

(b) Data transmissions between MPS-RMS to verify meeting subsystem performance requirements.

(c) Man-machine functional tests with portable terminal.

(d) A selected group of tests from the factory subsystem and equipment tests to verify on-site system performance to be conducted concurrently with a 48-hour stability test.

5. PREPARATION FOR DELIVERY

5.1 Packing. - Unless otherwise specified in the contract, equipment shall be prepared for domestic shipment in accordance with MIL-E-17555, Level A.

5.2 Marking. - Where two or more units are packed in a common shipping container, each unit shall be packed with any necessary accessories and marked so that it can be identified and reshipped individually without repacking. Each package and shipping container shall be legibly marked with the following information:

(a) Name of item and FAA designation

(b) Serial number

(c) Quantity

(d) Contract number

(e) National stock number (NSN)

(f) Manufacturer's name

6. NOTES.

6.1 None.

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For Figures I through 5, see pages 52 through 59.
For Tables I through III, see pages 60 through 66.
For Appendicies I through 5, see pages 67 through 71.
For Table of Contents, see pages 72 through 81.

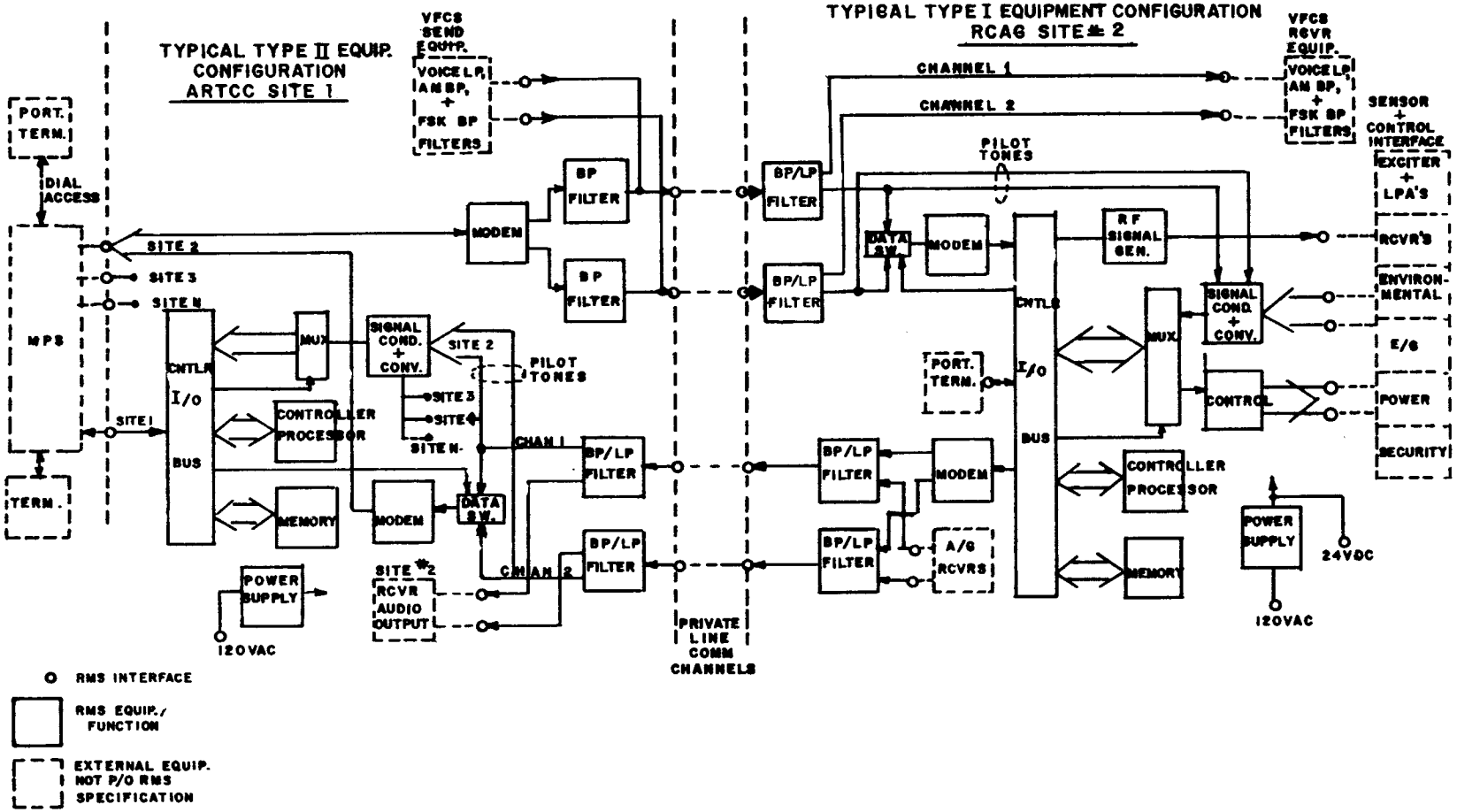
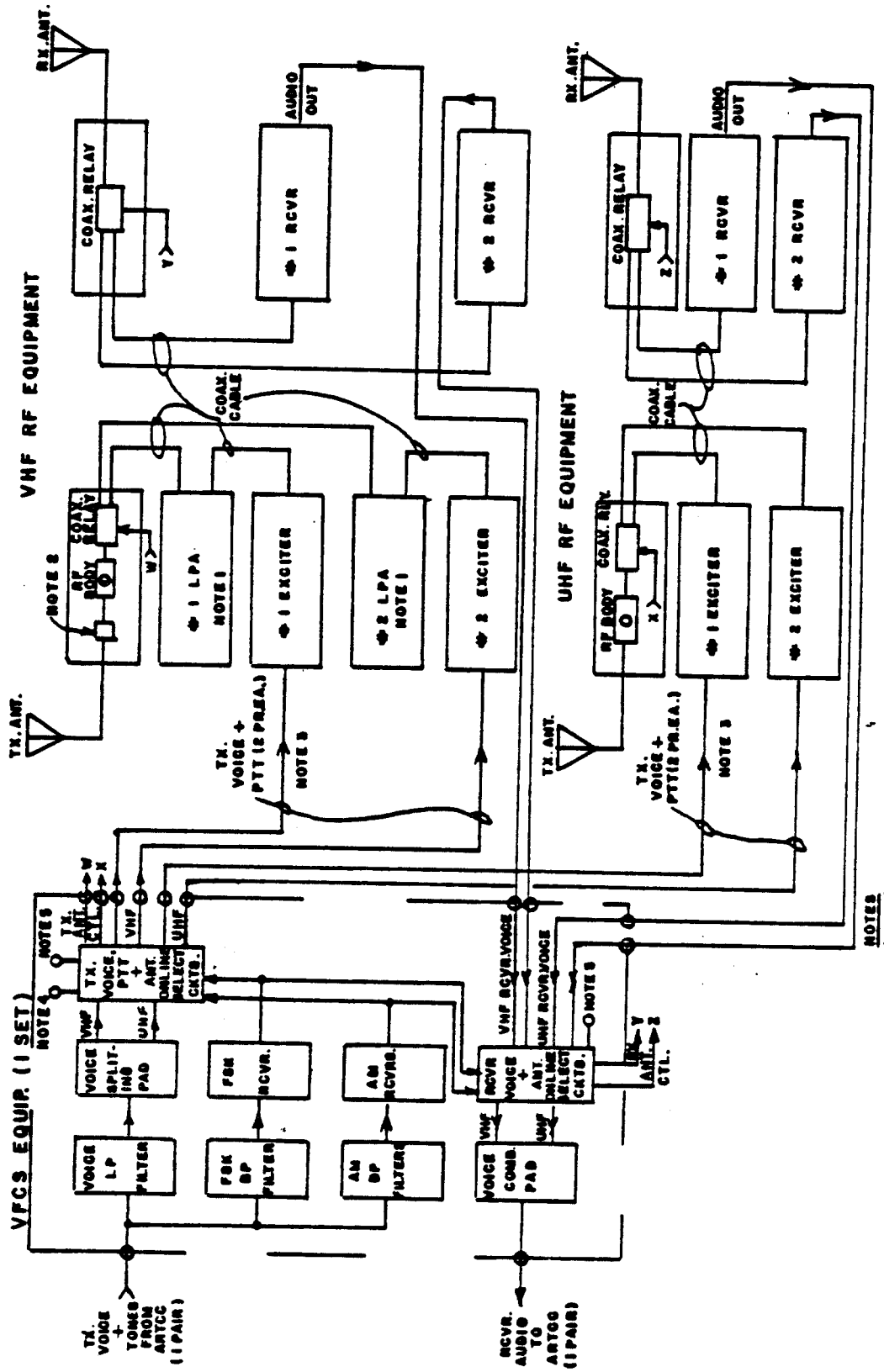


FIGURE 1 RCAG RMS

SUBSYSTEM FUNCTIONAL BLOCK DIAGRAM
TWO PAIRED OR SELECTIVE A/G CHANNEL

FAA-E-2699



NOTES

1. LPA'S CAN BE INSTALLED ON VHF, UHF, BOTH OR NONE.
2. SUGGESTED LOCATION FOR TYPE I RMS LPA FORWARD AND REVERSE PWR SENSORS.COAXIAL CABLE HAS A NOMINAL IMPEDANCE OF 50 OHMS.
3. PAIRED CONFIGURATION DIFFERS FROM SELECTIVE ONLY IN METHOD OF TRANSMITTER KEYING.
4. EXTERNAL INTERFACE POINTS FOR PTT OPTIONS (2 EACH).
5. EXTERNAL INTERFACE POINTS FOR ON/OFF LINE SELECT OPTION (8 EACH).

FIGURE 2 - RCAG EQUIPMENT: ONE PAIRED OR ONE SELECTIVE CHANNEL.

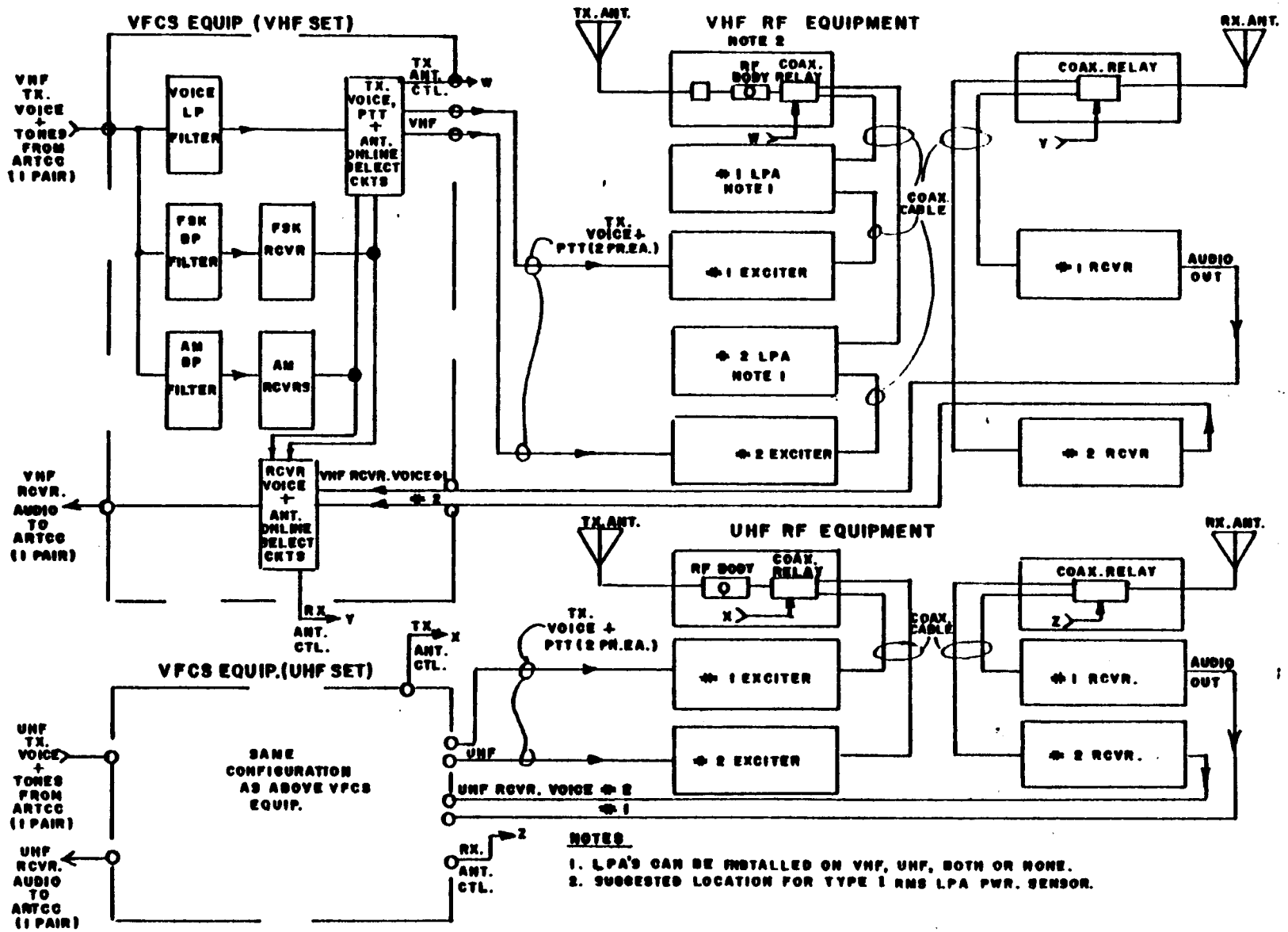


FIGURE 3- RCAG EQUIPMENT, ONE SPLIT CHANNEL

CERTIFICATION DATA REPORT

ZZZ RCAG 12/7/78 12:00:00

CHNL 1: 118.8/360.8 PAIRED OPERATION

ON LINE EQUIP.: VHTX=1/VHRX=2/UHTX=1/UHRX=2

VHF TRANSMITTERS: EFWP*10.0W/ESWR=1.30/MODA*NML/VFIN=NML/
PTT#=047/LFWP=XXXW/LSWR=XXX

UHF TRANSMITTERS: EFWP*XXX/ESWR=XXX/MODA*NML/VFIN=NML/
PTT#=XXX/LFWP=51.7W/LSWR=1.32

VHF RECEIVERS: SNNR=18.5dB/AGCV=NML/VFOU=NML

UHF RECEIVERS: SNNR=16.7dB/AGCV=NML/VFOU=NML

PILOT TONE LEVELS: VTXL=-25.7dBm/VRXL=-24.5dBm/UTXL=XXX dBm/
URXL=XXXdBm

CHNL 2: 125.9/317.4 SPLIT OPERATION

ON-LINE EQUIP.: VHTX=1/VHRX=1/UHTX=2/UHRX=2

VHF TRANSMITTERS: EFWP*XXX/ESWR=XXX/MODA*HI/VFIN=HI/
PTT#=125/LFWP=53.8W/LSWR=2.45

UHF TRANSMITTERS: EFWP*11.9W/ESWR=1.58/MODA*LOW/VFIN=LOW/
PTT#=205/LFWP=ALM/LSWR=ALM

VHF RECEIVERS: SNNR=9.8dB/AGCV=LOW/VFOU=LOW

UHF RECEIVERS: SNNR=25.4dB/AGCV=NML/VFOU=HI

PILOT TONE LEVELS: VTXL=-22.5dBm/VRXL=-26.4dBm/UTXL=-34.7 dBm/
URXL=-24.8 dBm

ENVIRONMENTAL/SECURITY: ELRT=23.7 DEG/EGRT=29.7 DEG/FIRE=NML/
SMKE=NML/SECY=BYP/SIGN=ON

POWER/ENGINE-GENERATOR: ACV1=121V/ACV2=125V/DCV1=28.4V/SFTY=NML

COMMAND-STATUS: EGST=RUN/SNRT=OFF/RMST=OFF/DTSW=1/MRST=OFF/
STRT=OFF/HVAC=LKT/VFEN=ENS/MODS=ENS

FIGURE 4. SAMPLE PRINTOUT FORMAT

PARAMETER LEGEND

PARAMETER	FORMAT	DATA FORMAT
ON-LINE EQUIPMENT		
VHF TRANSMITTER ON-LINE STATUS	VHTX	1 = TX 1 ON-LINE 2 = TX 2 ON-LINE
VHF RECEIVER ON-LINE STATUS	VHRX	1 = RX 1 ON-LINE 2 = RX 2 ON-LINE
UHF TRANSMITTER ON-LINE STATUS	UHTX	1 = TX 1 ON-LINE 2 = TX 2 ON-LINE
UHF RECEIVER ON-LINE STATUS	UHRX	1 = RX 1 ON-LINE 2 = RX 2 ON-LINE
TRANSMITTER PARAMETERS		
EXCITER FORWARD POWER (ON-LINE)	EPFW	W = WATTS
EXCITER VOLTAGE STANDING WAVE RATIO (ON-LINE)	ESWR	RATIO (NO UNITS)
PERCENT MODULATION (ON-LINE)	MODA	NML = NORMAL HI = HIGH ALARM LOW = LOW ALARM or % = PERCENTAGE
VOICE FREQUENCY INPUT LEVEL (ON-LINE)	VFIN	NML = NORMAL HI = HIGH ALARM LOW = LOW ALARM or dBm = DECIBELS
PUSH-TO-TALK COUNT	PTT#	NUMBER (NO UNITS)
LPA FORWARD POWER (ON-LINE)	LFWP	W = WATTS
LPA VSWR (ON-LINE)	LSWR	RATIO (NO UNITS)
RECEIVER PARAMETERS		
SIGNAL-PLUS-NOISE TO NOISE RATIO (OFF-LINE)	SNNR	dB = DECIBELS
AUTOMATIC GAIN CONTROL VOLTAGE (ON-LINE)	AGCV	NML = NORMAL LOW = LOW ALARM
VOICE FREQUENCY OUTPUT LEVEL (ON-LINE)	VFOU	NML = NORMAL HI = HIGH ALARM LOW = LOW ALARM
PILOT TONE LEVELS		
VHF TRANSMIT LINE RECEIVE LEVEL	VTXL	dBm = DECIBELS (1 MW)
VHF RECEIVE LINE RECEIVE LEVEL	VRXL	"
UHF TRANSMIT LINE RECEIVE LEVEL	UTXL	"
UHF RECEIVE LINE RECEIVE LEVEL	URXL	"

FIGURE 4. SAMPLE PRINTOUT FORMAT (CONTINUED)

PARAMETER LEGEND (continued)

ENVIRONMENTAL/SECURITY PARAMETERS

ELECTRONICS ROOM TEMPERATURE	ELRT	DEG = DEGREES CELSIUS
ENGINE/GENERATOR ROOM TEMPERATURE	EGRT	"
FIRE ALARM	FIRE	NML = NORMAL ALM = FIRE ALARM
SMOKE ALARM	SMKE	NML = NORMAL ALM = SMOKE ALARM
SECURITY ALARM	SECY	NML = NORMAL ALM = SECURITY ALARM BYP = ALARM BY-PASSED
RMS SIGN ON/OFF	SIGN	ON = OPERATOR SIGNED ON OFF = OPERATOR SIGNED OFF

POWER/ENGINE GENERATOR PARAMETERS

AC VOLTAGE (LINE 1 TO NEUTRAL)	ACV1	V = AC VOLTS
AC VOLTAGE (LINE 2 TO NEUTRAL)	ACV2	"
DC VOLTAGE	DCV1	V = DC VOLTS
E/G SAFETY ALARM	SFTY	NML = NORMAL ALM = ALARM

COMMAND-STATUS PARAMETERS

E/G START/STOP	EGST	OFF = E/G OFF RUN = E/G RUNNING
SIGNAL-PLUS-NOISE TO NOISE TEST	SNRT	OFF = TEST NOT IN PROGRESS ON = TEST IN PROGRESS/ COMMAND RECEIVED.
RMS SELF TEST	RMST	"
DATA SWITCH (BOTH TYPE 1 & TYPE 2)	DTSW	1 = DATA LINE 1 IN USE 2 = DATA LINE 2 IN USE 0 = TYPE I & II data switch positions different-data switch alarm report (MPS generated)
RMS MASTER RESET	MRST	OFF = RESET NOT IN PROGRESS ON = RESET IN PROGRESS/ COMMAND RECEIVED

FIGURE 4. SAMPLE PRINTOUT FORMAT (CONTINUED)

PARAMETER LEGEND (continued)

COMMAND-STATUS PARAMETERS (continued)

RMS STARTUP OR RECOVERY MODE	STRT	OFF = STARTUP/RECOVERY NOT IN PROGRESS ON = STARTUP/RECOVERY IN PROGRESS OR COMMAND RECEIVED
HEATING/VENTILATING/ AIR CONDITIONING LOCKOUT	HVAC	ULK = UNLOCKED LKT = LOCKED OUT
VOICE FREQUENCY INPUT ENABLE (3.5.2.6)	VFEN	ENS = ALL ON-LINE VFIN PARAMETERS ENABLED (REPORT HI/ LOW/NML) ENA = ALL ON-LINE VFIN PARAMETERS ENABLED (REPORT dBm VALUES) DIS = ALL ON-LINE VFIN PARAMETERS DISABLED
PERCENT MODULATION SELECT (3.5.2.6)	MODS	ENS = REPORT PERCENT MODULATION AS HI/LO/NML ENA = REPORT PERCENT MODULATION AS PERCENTAGE

Notes: 1. Following above parameter information there shall be a list of current alarms, alarm thresholds, pre-alarms, disabled alarms and parameters that have alarmed and returned-to-normal (RTN) since the last certification data report.

2. XXX denotes masked (nonexistent) parameter.

3. Asterisk (*) in place of equals (=) denotes change in alarm threshold from established standard value (3.6.3.2).

FIGURE 4. SAMPLE PRINTOUT FORMAT (CONTINUED)

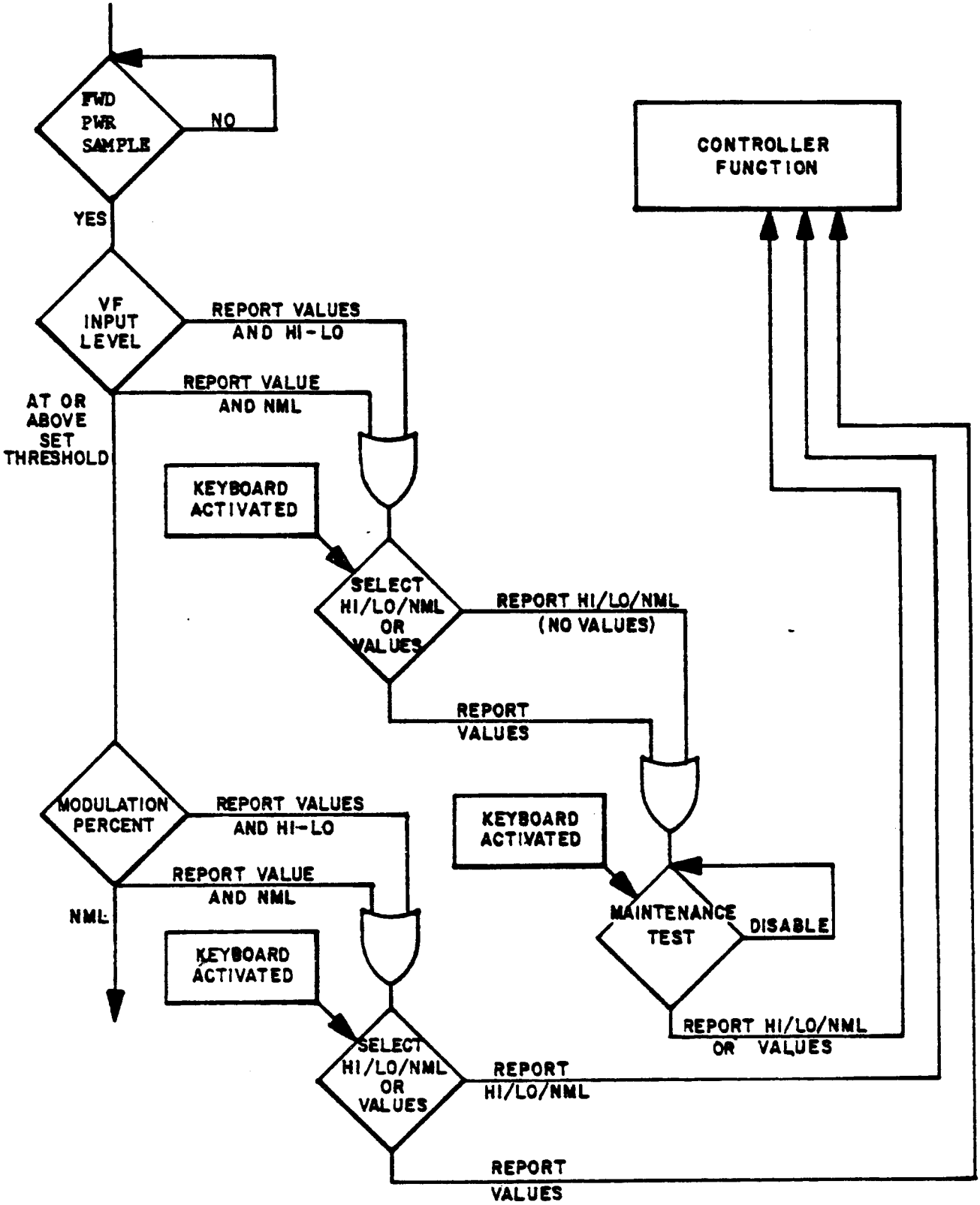


FIGURE 5.
TEST FUNCTION FOR
VF INPUT LEVEL

TABLE I

SUBSYSTEM SIZING AND MODULARITY REQUIREMENTS

MONITORING SENSOR POINT EXTERNAL INTERFACES

ITEM	DESIGN REQUIREMENTS MINIMUM (BASIC) TYPE I	MINIMUM (BASIC) TYPE II	MAXIMUM TYPE I	MAXIMUM TYPE II
1. A/G radio channel[1]	1	12	6	120
VHF frequencies	1	12	6	120
UHF frequencies	1	12	6	120
2. Exciter sensor points				
Forward power	4	-	24	-
Reverse power	4	-	24	-
PTT status	4	-	24	-
VF input level	4	-	24	-
On-line/off-line status[2]	2	-	12	-
Percent modulation	4	-	24	-
3. LPA sensor points				
Forward power	2	-	12	-
Reverse power	2	-	12	-
10 watt/50 watt status[3]	4	-	24	-
4. Receiver sensor points				
AGC voltage	4	-	24	-
VF output level[9]	4	-	24	-
On-line/off-line status[4]	2	-	12	-
5. Primary power sensor points				
Equipment DC voltage	1	-	1	-
AC voltage[5]	1 or 2	-	1 or 2	-
E/G ON/OFF status	1	-	1	-
E/G master safety switch	1	-	1	-

TABLE I (Continued)

ITEM	DESIGN REQUIREMENTS MINIMUM (BASIC) TYPE I	MINIMUM (BASIC) TYPE II	MAXIMUM TYPE I	MAXIMUM TYPE II
6. Pilot tone sensors per communications channel[9,6]				
Split channel	2	24	12	240
Paired channel	1	12	6	120
Selective channel	1	12	6	120
7. Data switch status	1	12	1	40
8. Environmental and security sensor points				
Ambient room temperature[7]	2	-	2	-
Smoke detector[8]	1	-	1	-
Building entrance doors	2	-	2	-
Security bypass switch	1	-	1	-
9. Spare sensor interfaces				
Analog	1	12	6	40
Digital	1	-	6	-

NOTES:

1. A radio channel shall have one (1) each VHF and UHF frequency.
2. Status of transmit antenna coaxial relay.
3. Sensor point on associated exciter.
4. Status of receive antenna coaxial relay.
5. Either two sensor points for 1 phase, 3-wire power; or 3 phase, 4-wire power; or one sensor point for 1 phase, 2-wire power.
6. Sensor points on each circuit of 4-wire channel, at both Type I and Type II locations.
7. Temperature sensor set for fire alarm in both rooms at 66°C.
8. Sensor in equipment room.
9. Number of sensor points shall be governed by the number and mix of split, paired or selective channels as stated in the contract schedule for each RCAG site.

TABLE II

SUBSYSTEM COMMAND/CONTROL EXTERNAL INTERFACES

ITEM		DESIGN REQUIREMENTS MIN (BASIC)	MAX.
1.	Type I equipment		
a.	private line communications channels (3.4.6)	2[1]	2[1]
b.	E/G start/stop (3.6.3.6)	1	1
c.	Heat ventilation/air conditioning (HVAC) equipment lockout (3.6.3.7	1	1
d.	push-to-talk (PTT)	1	12
e.	on-line/off-line command on exciter/receiver select basis[2,4] (3.6.3.5)	4	24
f.	Terminal/portable terminal[3] (3.6.3)	1	1
g.	data switch (3.5.8)	1	1
h.	VF input disable/enable (3.5.2.6)	1	1
i.	Master reset (3.6.3.2)	1	1
2.	Type II equipment		
a.	private line communication channel (3.4.6)	24	80
b.	MPS-RMS modem[5] (3.4.1)	12	40
c.	MPS-RMS controller (3.5.4)	1	1
d.	Data switch (3.5.8)	12	40
e.	Master reset (3.6.3.3)	1	1

TABLE II (Continued)

NOTES:

1. Interface to different 4-wire channels, except for sites with only one (1) 4-wire channel between ARTCC and RCAG.

2. PTT and on-line/off-line control/select functions to be correlated in program memory.

3. Equipment not part of this specification requirement.

4. Number of interfaces shall be governed by the number of channels specified in the contract schedule.

5. Number of interfaces shall be determined by the number of RMS interconnected to an ARTCC/MPS.

TABLE III
REPORTED PARAMETERS FOR
CERTIFICATION/STATUS DATA REPORT

All parameters listed below are Type I RMS parameters. Parameters designated by an asterisk (*) are both Type I and Type II RMS parameters. See notes b. and c.

	PARAMETER	REPORT UNIT	RANGE	INCREMENT
a.	Exciter status	on-line status(S)	—	—
b.	Exciter forward power	watts(Q)	5 to 15	0.1 watt
	High	alarm	10 to 15	
	Low	alarm	5 to 10	
c.	Exciter VSWR	ratio(Q)	1.0 to 4.0:1	0.1
	High	alarm	1.5:1 to 4.0:1	
	Low (sensor check)	alarm	1.0:1 to 1.1:1	
d.	LPA forward power	watts(Q)	30 to 65	0.5 watt
	High	alarm	50 to 65	
	Low	alarm	30 to 50	
e.	LPA VSWR	ratio(Q)	1.0 to 4.0:1	0.1
	High	alarm	1.5:1 to 4.0:1	
	Low (sensor check)	alarm	1.0:1 to 1.1:1	
f.	PTT occurrence	per interval(Q)	0 to 256	each
g.	VF input (see note a)	HI/NML/LOW (S) or dBm (Q)	-8dBm to -40dBm	0.5 dB
	High	alarm	-8dBm to -25dBm	
	Low	alarm	-20dBm to -40dBm	

TABLE III (Continued)

	PARAMETER	REPORT UNIT	RANGE	INCREMENT
h.	Percent modulation (see note a)	HI/NML/LOW(S) or percentage (Q)	20 to 100	1.0 percent
	High	alarm	80 to 100	
	Low	alarm	20 to 80	
i.	Receiver status	on-line status(S)	—	—
j.	AGC voltage	NML/LOW(S)	0 to 18	0.1 volt
	Low	alarm	same as above	
k.	VF output	HI/NML/LOW(S)	0dBm to -40dBm	0.5 dB
*	Low	alarm	-10dBm to -40dBm	*
	High	alarm	-20dBm to 0dBm	
l.	S+N/N	ratio (Q)	5 to 40	0.5 dB
	High (sensor check)	alarm	30 to 40	
	Low	alarm	5 to 30	
m.	Pilot tone receive*	level (Q)	-15dBm to -45dBm	0.5 dB
	High	alarm	-15dBm to -30dBm	
	Low	alarm	-30dBm to -45 dBm	
n.	Primary AC power	volts (Q)	90 to 150	1.0 volt
	High	alarm	120 to 150	
	Low	alarm	90 to 120	
o.	RMS DC power	volts (Q)	18 to 30	0.1 volt
	High	alarm	24 to 30	
	Low	alarm	18 to 24	

TABLE III (Continued)

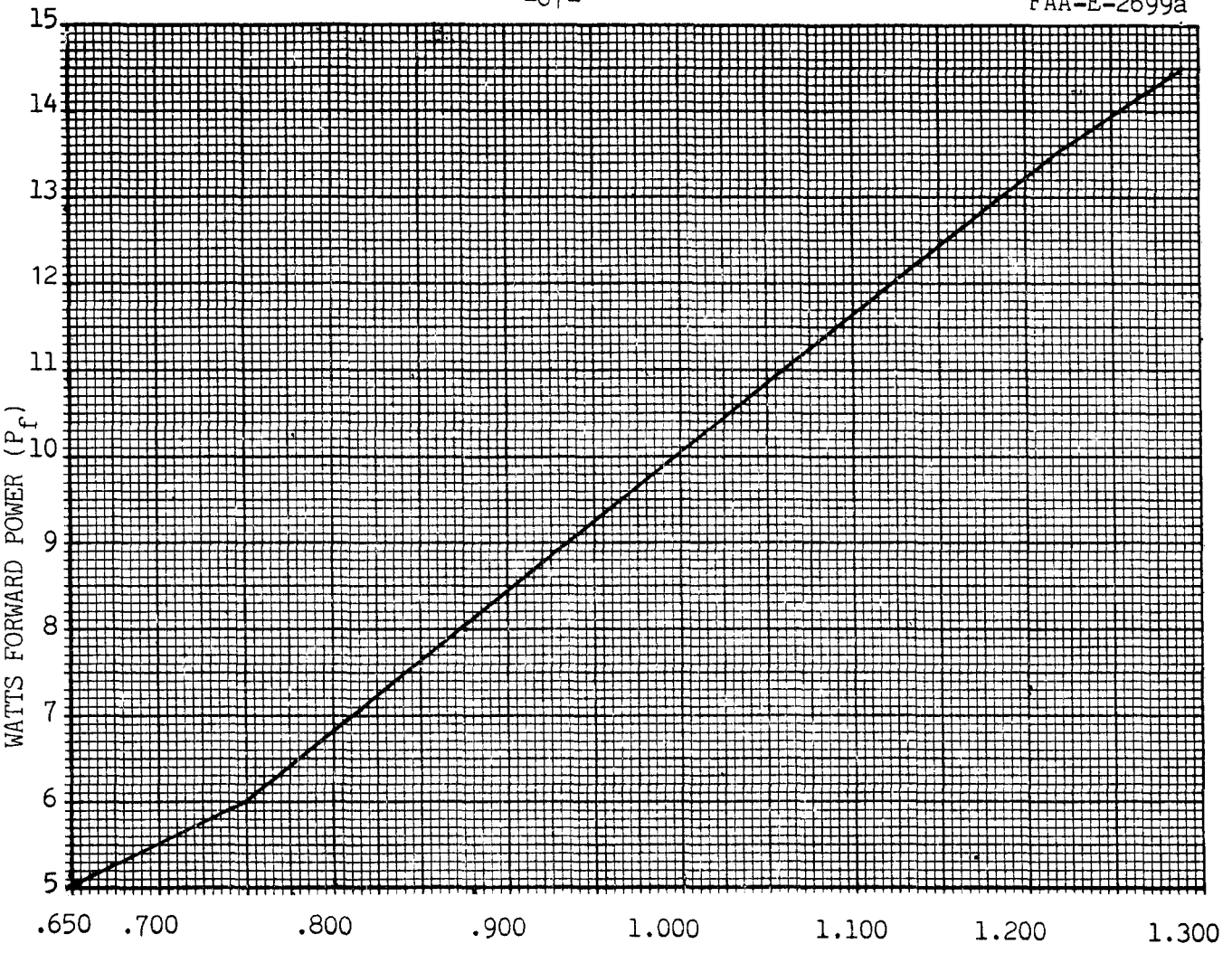
	PARAMETER	REPORT UNIT	RANGE	INCREMENT
p.	E/G master safety switch	normal/ alarm(S)	0/24 or 0/32 VDC	—
q.	E/G status	ON/OFF(S)	—	—
r. *	Ambient temperature status (two each)	degrees C(Q)	-20 to 70	1.0 degree *
s.	Fire	alarm/normal (S)	66°C for 1 minute	—
t.	Smoke	alarm/normal (S)	—	—
u.	Door security	alarm/normal/ bypass(S)	—	—
v.	RMS sign on/off	on/off (S)	—	—
w.	Monitor	alarm/normal (S)	—	—
x.	CRC	alarm/normal (S)	—	—
y.	Data switch position*	0,1 or 2 (S)	—	—
		1 or 2 = normal 0 = alarm (MPS generated)	—	—
z.	Start-up/recovery	alarm A/alarm B/ alarm C/alarm D/ alarm E/normal (S)	—	—

alarm A = initiated by power failure
alarm B = initiated by MPS
alarm C = initiated by restart timer timeout
alarm D = initiated by manual entry, local or remote
alarm E = initiated by self-test errors

Note: a) See paragraph 3.5.2.6 for requirements.

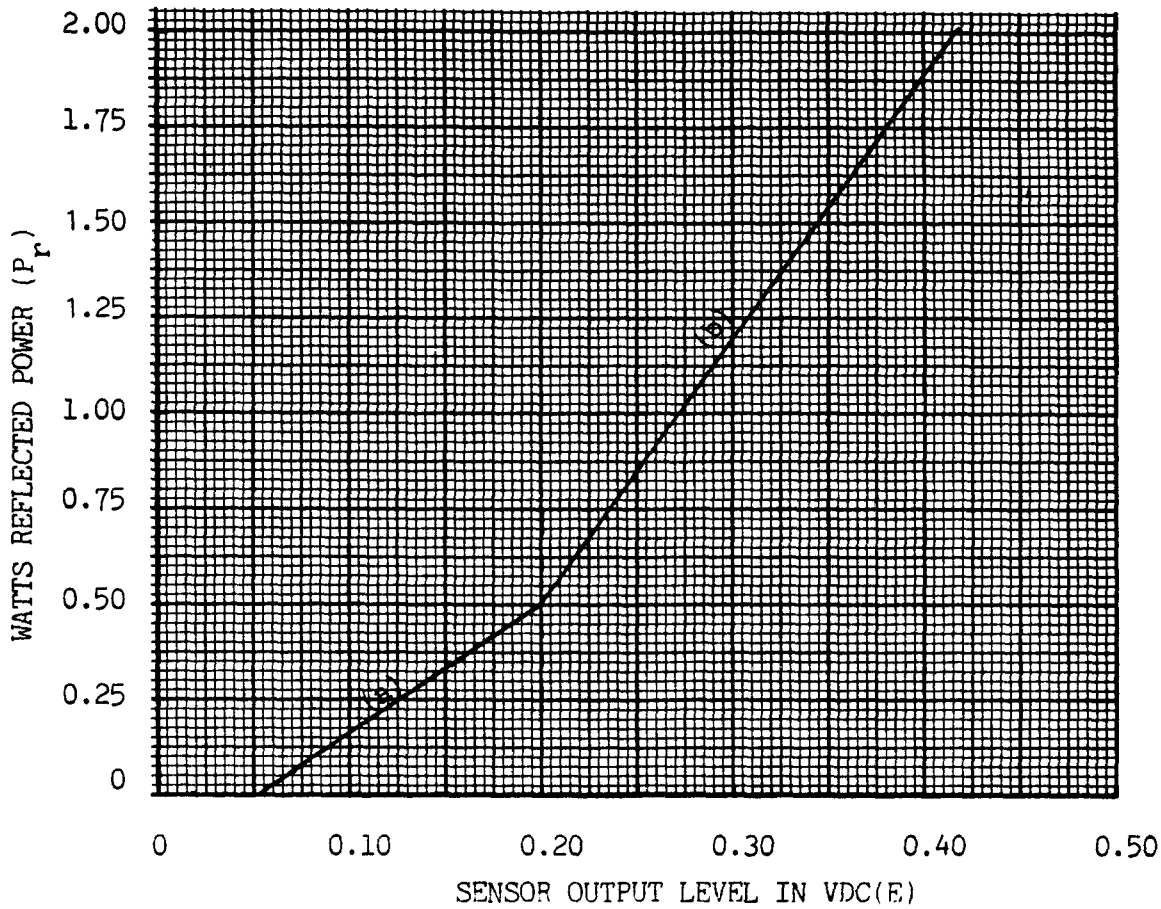
b) All analog parameters shall be reported as quantified(Q) values over the range specified.

c) All status parameters(S) shall be reported as indicated for the parameter.



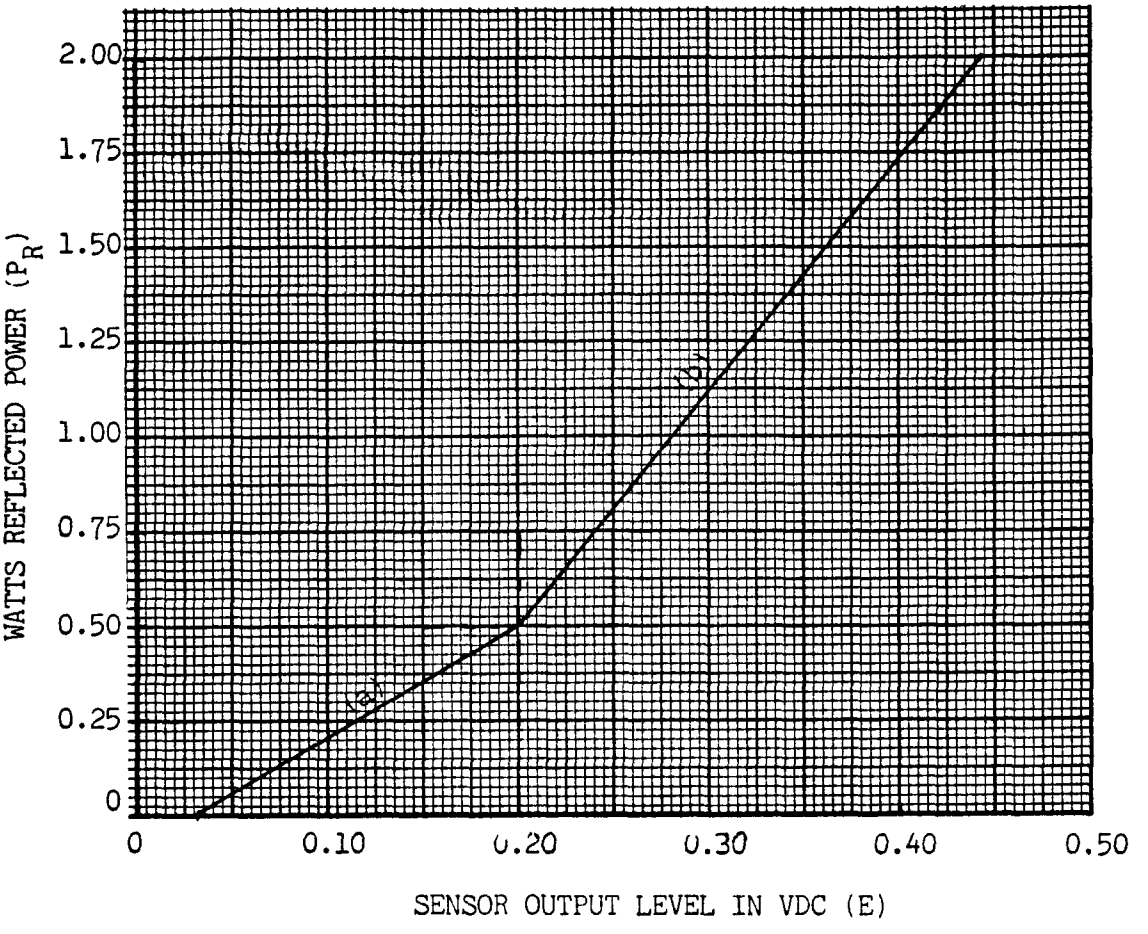
1. The sensor output level is set to a reference set level of 1 VDC ±5MV under the equipment operating conditions of 10 watt unmodulated RF carrier forward power (P_f) into a 50 ohm load. The sensor output voltage will vary with a change in RF forward power on the transmission line.
2. With the RF carrier modulated at 90 percent for test tones over the range of 0.3 to 3.0 KH_z, sensor output will vary no more than ±6MV from the 1 VDC set reference level for 10 watts unmodulated carrier.
3. Sensor output impedance is 300 ohms, resistive ±5 percent.

Appendix 1 - VHF and UHF forward power characteristics



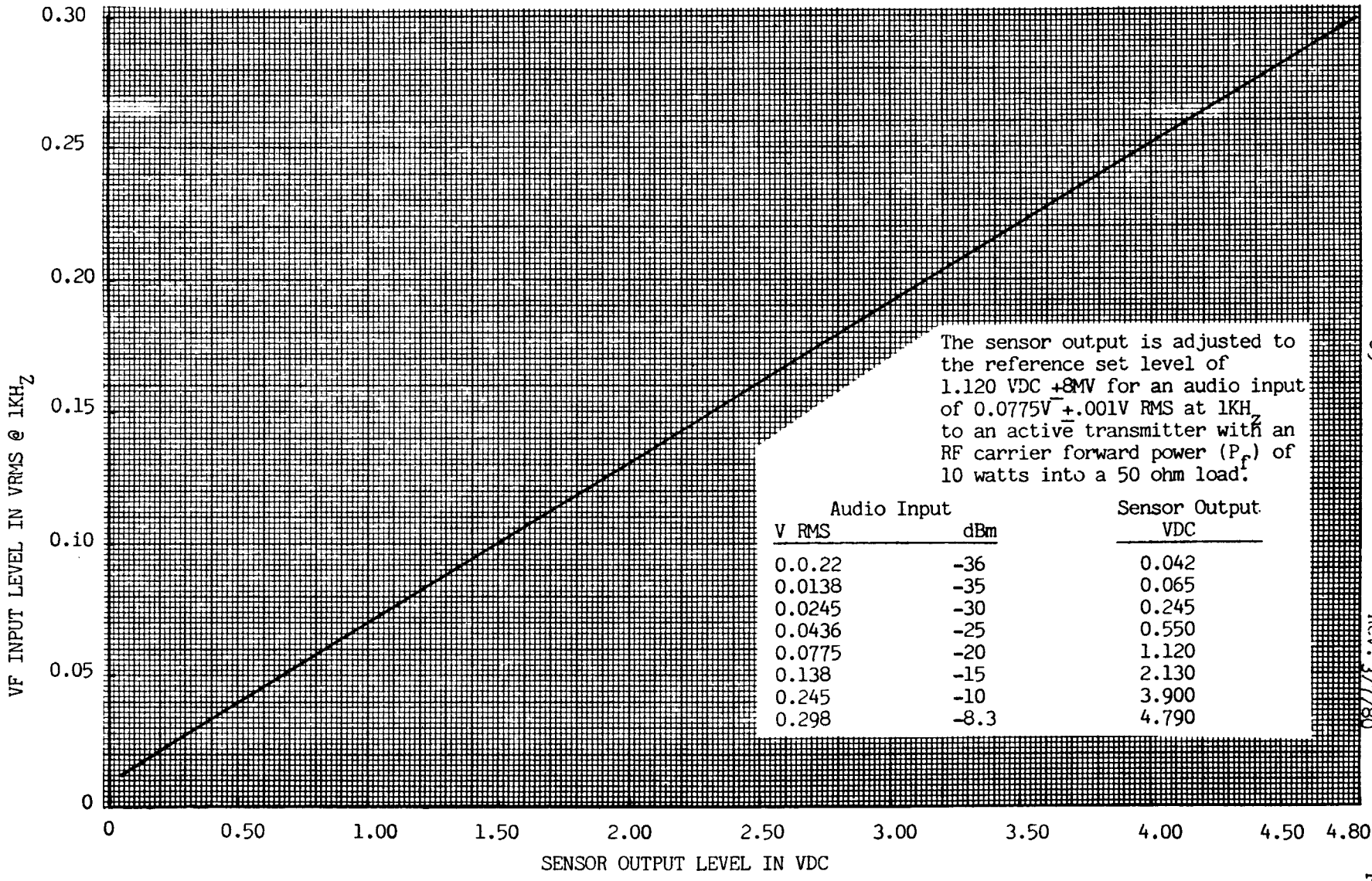
1. The sensor output level is set to a reference set level(E) of 0.295 VDC±2MV under equipment operating conditions of 10 watts unmodulated RF forward power(P_f) into a mismatch load that results in a VSWR of 2.00:1. The sensor output voltage will vary with a change in RF reflected power(P_r) in the transmisssion line.
2. With the RF carrier modulated at 90 percent for test tones over the range of 0.3 to 3.0 KH_z, sensor output will vary no more than ±6MV from the 0.295 VDC set reference level for a 10 watt unmodulated carrier.
3. Reflected power (P_r) = $5E\sqrt{E}$ (for segment (a) characteristics)
   = $7E\sqrt{E}$ (for segment (b) characteristics)
4. Reflected power at 0.50 watts and below shall use segment (a) characteristics.
   Reflected power above o.50 watts shall use segment (b) characteristics.
5. $$VSWR = \frac{1 + \sqrt{P_r/P_f}}{1 - \sqrt{P_r/P_f}}$$
6. Sensor output impedance is 300 ohms, resistive + 5 percent.

Appendix 2A - VHF Reflected Power Sensor Characteristics



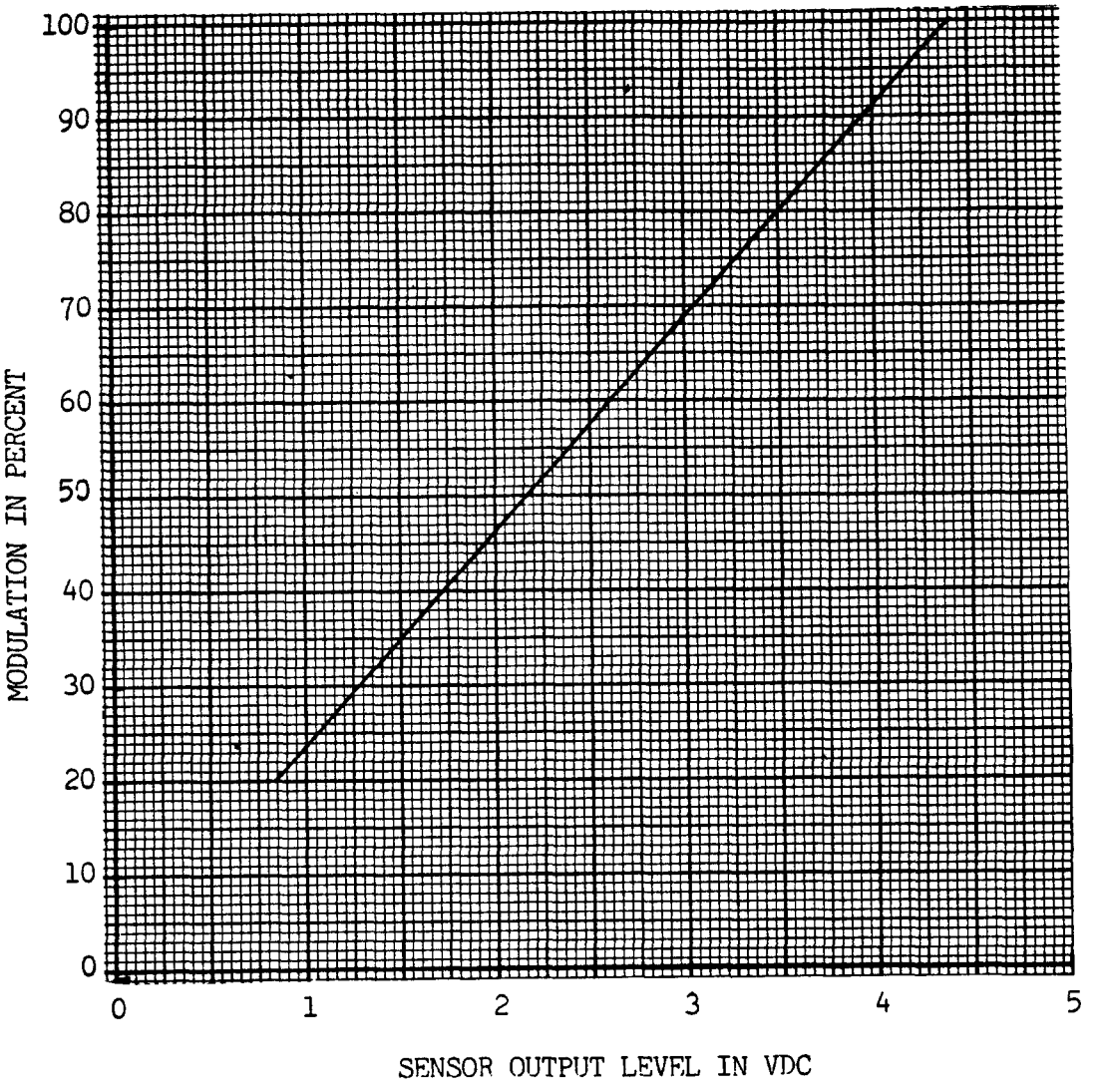
1. The sensor output level is set to a reference set level (E) of 0.305 VDC ±2MV under equipment operating conditions of 10 watts unmodulated RF forward power (P_f) into a mismatch load that results in a VSWR of 2.00:1. The sensor output voltage will vary with a change in RF reflected power (P_r) in the transmission line.
2. With the RF carrier modulated at 90 percent for test tones over the range of 0.3 to 3.0 KH_z, sensor output will vary no more than ±6MV from the 0.295 VDC set reference level for a 10 watt unmodultaed carrier.
3. Reflected power (P_r) = $5E\sqrt{E}$ (for segment (a) characteristics)
   = $7E\sqrt{E}$ (for segment (b) characteristics)
4. Reflected power at 0.50 watts and below shall use segment (a) characteristics. Reflected power above 0.50 watts shall use segment (b) characteristics.
5. $$VSWR = \frac{1 + \sqrt{P_r/P_f}}{1 - \sqrt{P_r/P_f}}$$
6. Sensor output impedance is 300 ohms, resistive ±5 percent.

Appendix 2B - UHF Reflected Power Sensor Characteristics



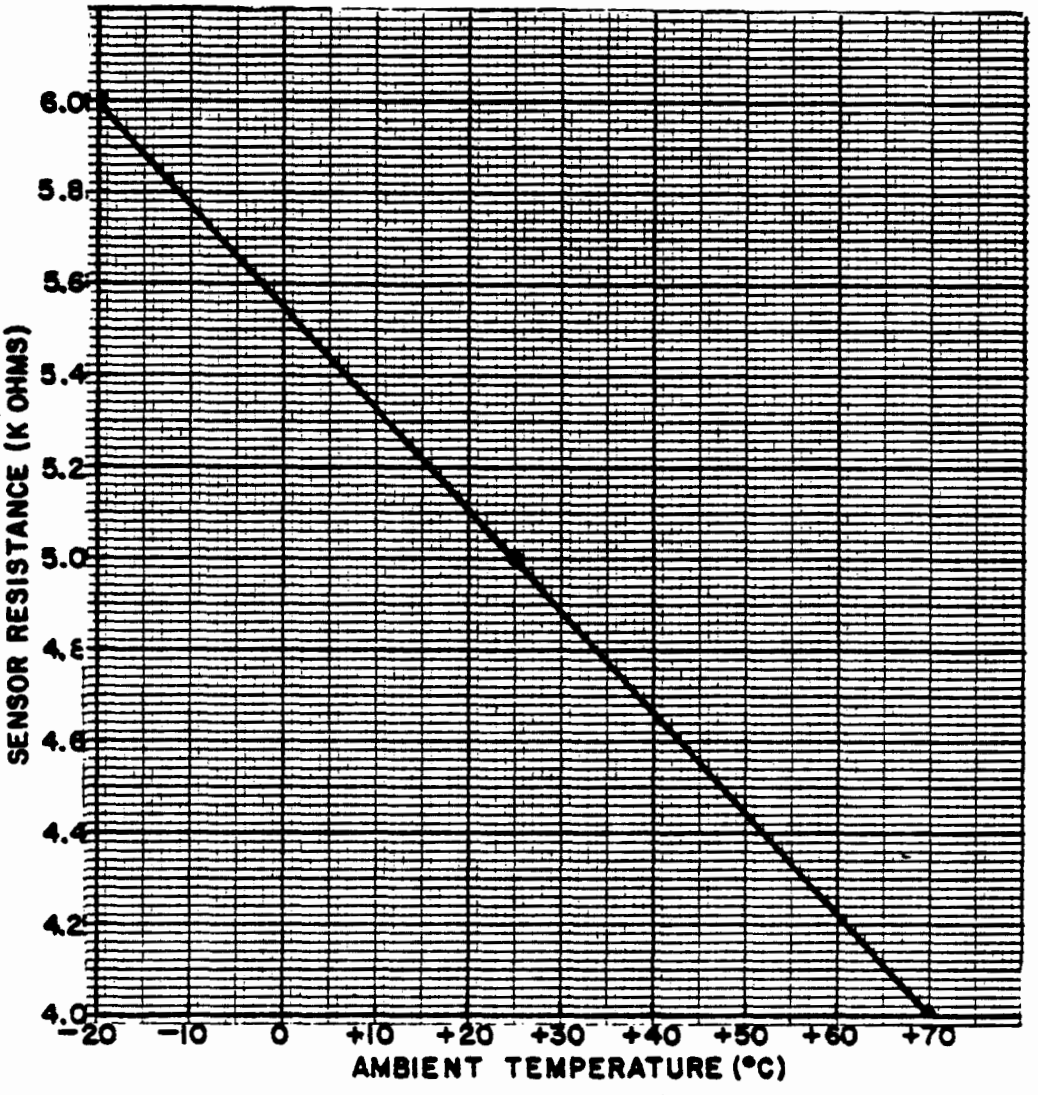
Audio Input V RMS	Audio Input dBm	Sensor Output VDC
0.0.22	-36	0.042
0.0138	-35	0.065
0.0245	-30	0.245
0.0436	-25	0.550
0.0775	-20	1.120
0.138	-15	2.130
0.245	-10	3.900
0.298	-8.3	4.790

Appendix 3 - VF Input Sensor Characteristics



1. The modulation sensor is adjusted for 4 VDC±20MV output with a 10 watt RF carrier modulated at $1KH_z$. A change in modulation is represented in a linear change in the monitor level.
2. Sensor output impedance is 300 ohms, resistive, ±5 percent.

Appendix 4 - Percent Modulation Sensor Characteristics



1. Sensor resistance changes at rate of 22.222 ohms/degree Celsius.

2. Sensor resistance is 5K ohms at 25°C.

3. Tolerance on resistance = ± 1% from-20°C to +70°C.

Appendix 5. Room Temperature Sensor Characteristics

APPENDIX 6

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FIGURES

TABLES

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